The WHAT'S NEW magazine

OCTOBER 1986 $1.75
CANADA $2.25

Popular Science

Carl Sagan's inside story —Voyager's triumph

THE PICKUP BOOM

4x4
F150
DAKOTA
S10
RADIAL GOODYEAR WRANGLER

sophisticated engineering and carlike amenities fuel their popularity

ANYTIME.

THE NEW DODGE POWER RAM 5

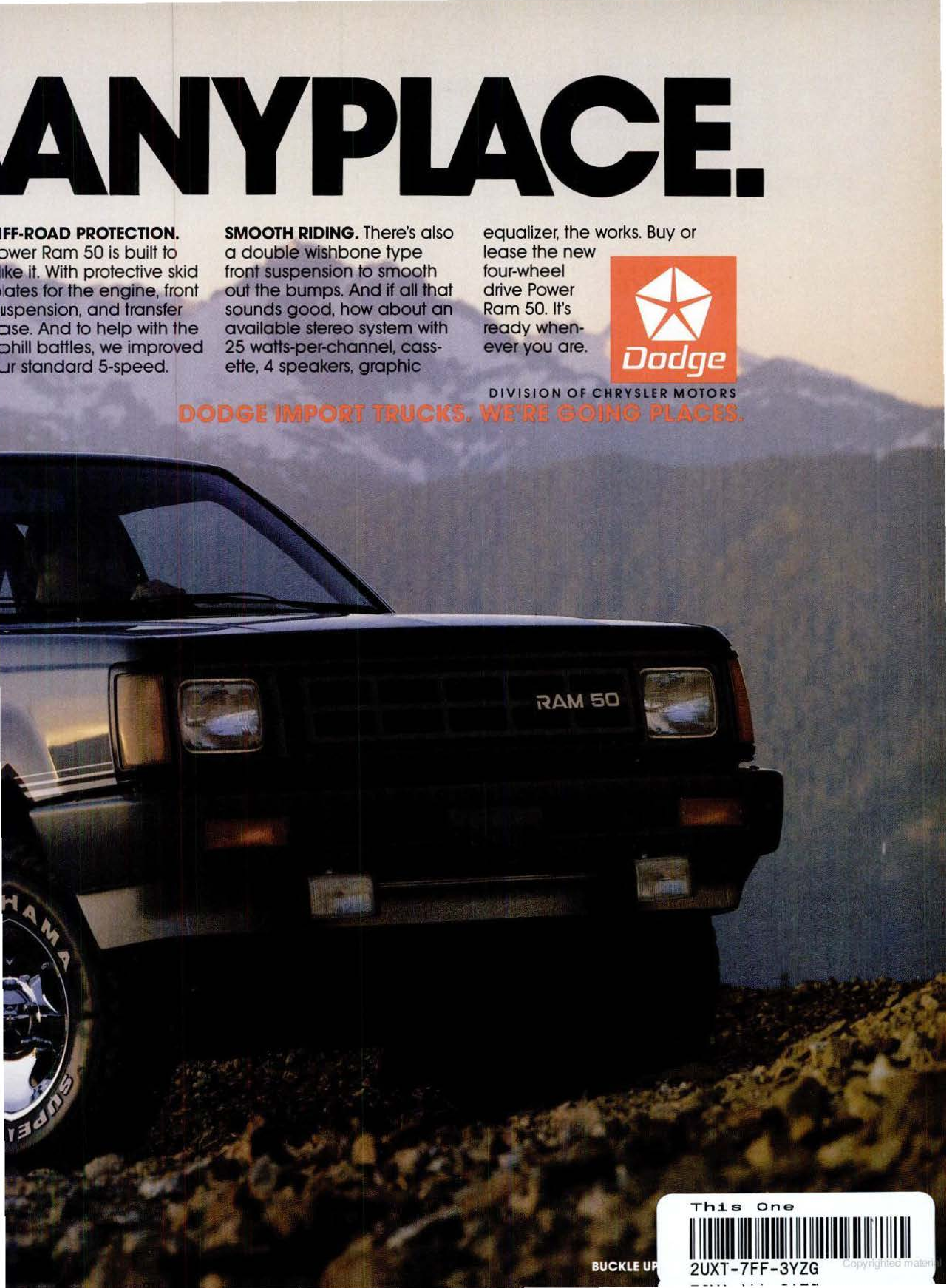
ALL NEW. IMPORTED FOR DODGE. BUILT BY MITSUBISHI MOTORS CORPORATION. AND RE-ENGINEERED BUMPER TO BUMPER.

Take it anywhere you want. Anywhere. Because the new Power Ram 50 has undergone some powerful changes. And it's ready for just about anything.

OFF-ROAD POWER. If you
power hungry, you've co
to the right place. This 4x
has the biggest 4-cylind
engine you can find in o
pickup.* A hefty 2.6 liters.

RAM 50
POWER RAM
SUPER DIGGER
YOKOHAMA
AT-R

*Based on data available at time of printing. Shown with dealer installed sport bar and lights.



ANYPLACE.

FF-ROAD PROTECTION. ower Ram 50 is built to ike it. With protective skid lates for the engine, front uspension, and transfer ase. And to help with the hill battles, we improved ur standard 5-speed.

SMOOTH RIDING. There's also a double wishbone type front suspension to smooth out the bumps. And if all that sounds good, how about an available stereo system with 25 watts-per-channel, cassette, 4 speakers, graphic equalizer, the works. Buy or lease the new four-wheel drive Power Ram 50. It's ready whenever you are.

Dodge

DIVISION OF CHRYSLER MOTORS

DODGE IMPORT TRUCKS. WE'RE GOING PLACES.

BUCKLE UP

This One
2UXT-7FF-3YZG

The WHAT'S NEW magazine
Popular Science®
OCTOBER 1986 Founded in 1872/Vol. 229, No. 4

Highlights of this issue

66

Boom year for pickups

As pickups pick up in popularity, auto makers respond with more-advanced and jazzier models.

76

Voyager's triumph

Carl Sagan recounts the heroics of the team that has made the Voyager mission a success.

80

21st-century superfighters

They're faster and deadlier: an in-depth look at the fighters of the future taking shape now.

88

Room at the top: Raise your roof

This renovation can double your living space —and solve other problems in the bargain.

Cover photo by Greg Sharko

The What's New digest......54–62

Science and Technology

Science newsfront......8
What's new—products and technology......54

Space and Aviation

Voyager's triumph......76
21st-century superfighters......80

Computers and Electronics

Optical strips beam images for flat TV......21
Electronics newsfront......22
Super-fast supercomputer......36
Laser copier edits your work......36
What's new in electronics......56
Video photography—the electronic revolution continues......74
Monster chips......104

Cars and Driving

Automotive newsfront......12
Car test: sports coupes—nimble, quick, and affordable......26
What's new for your car......58
Boom year for pickups......66
Detroit for '87: Chrysler, Ford, GM shift into high gear......70
Poor man's Porsche......87

Home, Shop, and Yard

Special Section:
New Products for Home Energy......40–53

Products

What's new for your lawn and garden......62
Fabulous faucets......92
No-shim door framing......100

Plans and Projects

Room at the top: Raise your roof to get more space for less money......88
A spa in the sun......94

Tools and techniques

What's new in tools......60

Car Care

"Say, Smokey—"......16
Taking care of your car......118

Additional Features

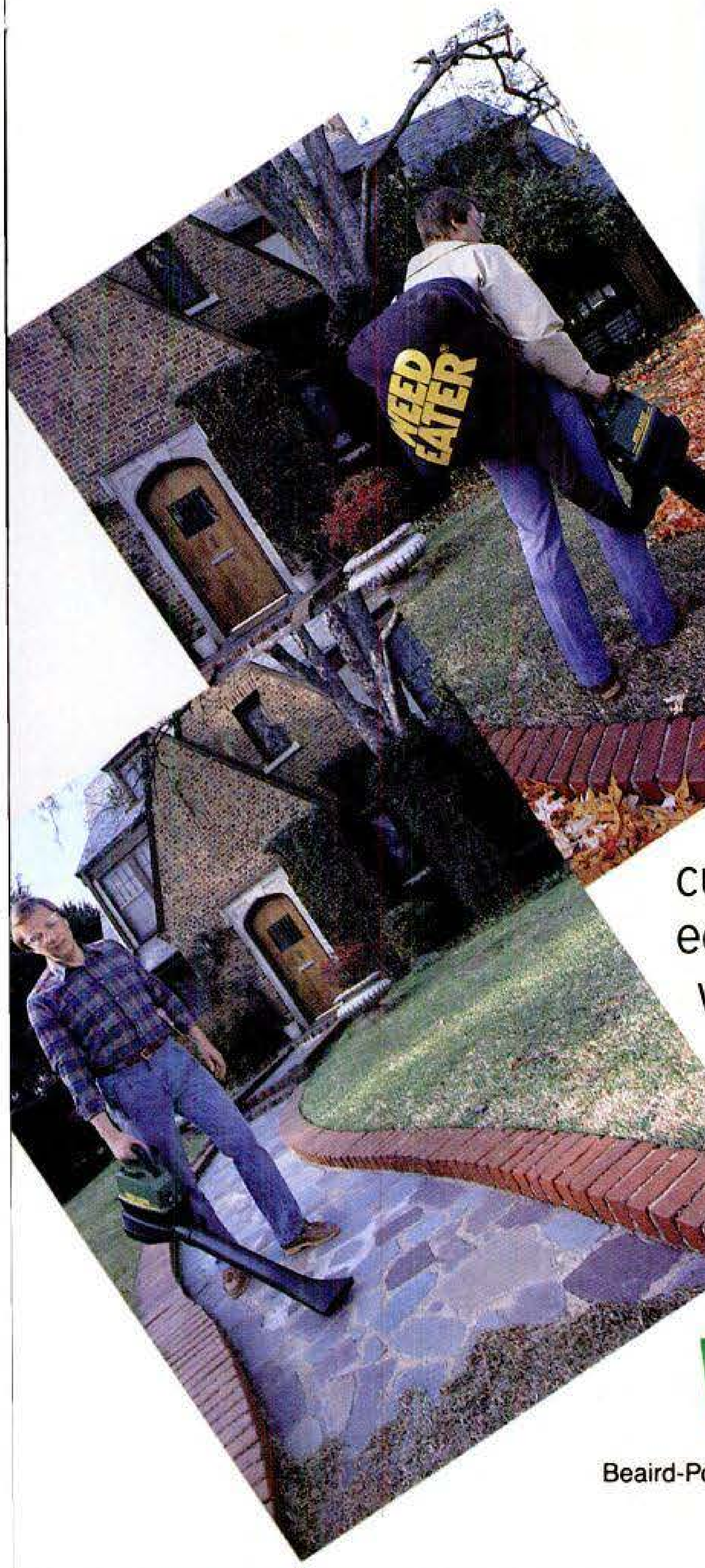
Readers talk back......4
What's news......65
Wordless workshop......120
Product information......136

POPULAR SCIENCE **BUSINESS AND EXECUTIVE OFFICES:** 380 Madison Ave., New York NY 10017. **EDITORIAL OFFICES:** Address contributions to Popular Science, Editorial Dept., 380 Madison Ave., New York NY 10017. We are not responsible for loss of unsolicited queries, manuscripts, or other materials. They will not be returned unless accompanied by return postage. Microfilm editions are available from Xerox University Microfilms Serial Bid Coordinator, 300 N. Zeeb Rd., Ann Arbor MI 48106. **SUBSCRIPTION INQUIRIES:** Send new or renewal notices or change of address (send both new and old addresses) to Popular Science, Box 2871, Boulder CO 80322. Allow six to eight weeks for change of address. Subscriptions: U.S. and its possessions, 1 year $13.94; 2 years $24.97; 3 years $34.97. Canada and elsewhere, 1 year $17.94; 2 years $34.95; 3 years $49.95. Subscriptions processed electronically. **POSTMASTER:** Send notices of undelivered copies (form 3579) to Popular Science, Box 2871, Boulder CO 80322. Popular Science entered as second-class postage at New York NY and additional mailing offices. Also entered as second-class matter at the P.O. Dept., Canada. Popular Science (ISSN 0161-7370) is published monthly by Times Mirror Magazines, Inc., 380 Madison Ave., New York NY 10017.

Copyright © 1986 by Times Mirror Magazines, Inc. All rights reserved. Contents may not be reprinted or otherwise reproduced without written permission. Popular Science® Mechanics and Handicraft®

NOW WEED EATER® BRINGS YOU A LAWN AND GARDEN TOOL THAT EVEN CLEANS UP AFTER ITSELF.

ON
OFF
CHOKE
WEED EATER®
BLOWER/VAC 960



Meet the Weed Eater gasoline-powered blower and blower/vac. Two of the most helpful lawn and garden tools since... well, since the Weed Eater trimmer. Like all Weed Eater products, they're designed to be a snap to operate. And the dependable two-cycle gasoline-powered engine cuts the cord, allowing you to go anywhere with ease. Now collecting leaves, sweeping drives and walks, clearing light snow, even cleaning up after a Weed Eater trimmer, is a year-round breeze. All in a lightweight, easy-to-use package. See the lawn and garden tool that cleans up after itself before your Weed Eater dealer is cleaned out.

WEED EATER® **The innovator in lawn and garden power tools.**

Beaird-Poulan/Weed Eater • Division Emerson Electric Co. • 5020 Flournoy-Lucas Rd. • Shreveport, La. 71129

Readers Talk Back

Address letters for this column to: Readers Talk Back, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

DAT's not da thing

I had been anxiously waiting for the introduction of the digital audio tape recorder. However, after reading your August story, my interest is gone. What good is a DAT recorder if the manufacturers have chosen to make it incompatible for recording CDs and prerecorded DATs? It would have been nice to make noiseless recordings, not only for playback on home DAT recorders, but also for future automotive units. Also, because this is a new format, prerecorded DATs, like CDs, will take some time in the marketplace to reach the competitiveness of standard audio tapes and LPs.

Ted Cumuze, Memphis, Tenn.

Family hot rod

The July article "Buick's Performance Car of the 1990s" was informative, but consider the title for a moment. The Wildcat has a 3.8-liter engine that delivers about 240 horsepower, and it weighs 3,400 pounds. But it takes 8.5 seconds to get from 0 to 60 mph. Now, the 1986 Buick Regal Grand National has a turbocharged 3.8-liter engine that delivers 235 horsepower; it weighs 3,350 pounds; and it smokes from 0 to 60 in six seconds flat. So please tell me, why is today's family car faster than tomorrow's performance car?

John Espallargas, Andrews, Texas

Tom Wilkinson replies: "Speed from 0 to 60 mph is determined by more than just weight and horsepower. Gear ratios and tire traction are especially important. Pretty much everything about the Regal is optimized for acceleration. The Wildcat, on the other hand, was intended to represent a more balanced approach to performance. Also, as we indicated, the weight, horsepower, and acceleration figures for the Wildcat were all supplied by Buick. They weren't about to let us stick the suction cup of our fifth wheel onto the Wildcat's hand-rubbed body and subject its prototype drive train to a half-dozen 0-to-60 runs."

Concrete overkill

The same day I read your August article on the 50th anniversary of Sakrete, a mason came to our house to discuss repairing our patio. When I asked about Sakrete, he shook his head and said, "Not enough cement." When I repeated your 4,000- and 5,000-psi test figures, he said he uses 20,000-psi and can get 40,000. With such a wide difference, maybe you should explain what to use for what.

Henry Wiersdorfer, Hamburg, N.Y.

Al Lees replies: "My short article was quite specific about which of the three Sakrete mixes to use for various purposes. Sakrete is packaged primarily for the do-it-yourselfer. If you're hiring a mason, let him mix his own concrete. But if he's aiming for 20,000 psi and above, it's rampant overkill. What is your patio to support that requires a 10-ton-per-square-inch base?"

Slab warning

"Successful Slabs Simplified" [July] was excellent, but there's an error in the sketch. The callout for the control-joint depth is confusing, though this is spelled out properly in the text. If someone interprets the drawing callout to mean that a control joint should be cut ¼ inch deep, a crack may form outside the groove. Control joints should be cut to a depth of one-fourth of a slab's thickness.

William C. Panarese, Manager
Building Technology Department
Portland Cement Assn., Skokie, Ill.

Aunt Eulalia resurrected

The system mentioned in "Gasoline/Electric Sports Car" [Aug.] is not really "totally new." With the addition of the flywheel generator and the on-board computer, it is a new twist to a very old idea. In the midst of the Paris Exposition of 1900 was a car that used

Continued

Popular Science

Editor-in-Chief C. P. Gilmore
Editor Herbert Shuldiner
Executive Editor Richard L. Stepler
Art Director W. David Houser

SCIENCE & TECHNOLOGY EDITOR Arthur Fisher
HOME & SHOP EDITOR Alfred W. Lees

COPY CHIEF Timothy O. Bakke

SENIOR EDITORS
Steven Ashley, John Free, V. Elaine Gilmore, William J. Hawkins, Dan McCosh, Tom Wilkinson

ASSOCIATE EDITORS
Stuart F. Brown, Naomi J. Freundlich, Jack Keebler, Dawn Stover

Copy Editors: Sherrill Clarke, Michael S. Neubarth

Staff Photographer: Gregory Sharko
Art Editors: John F. Crowley, Richard J. Meyer
Art Associate: Hugo Salhuana

Automotive: Jack Keebler, Dan McCosh *Detroit*, Tom Wilkinson
Electronics: William J. Hawkins
Home Improvement: Alfred W. Lees
Lawn & Garden: Timothy O. Bakke
Photography: Arthur Fisher
Recreation: Stuart F. Brown
Tools: V. Elaine Gilmore

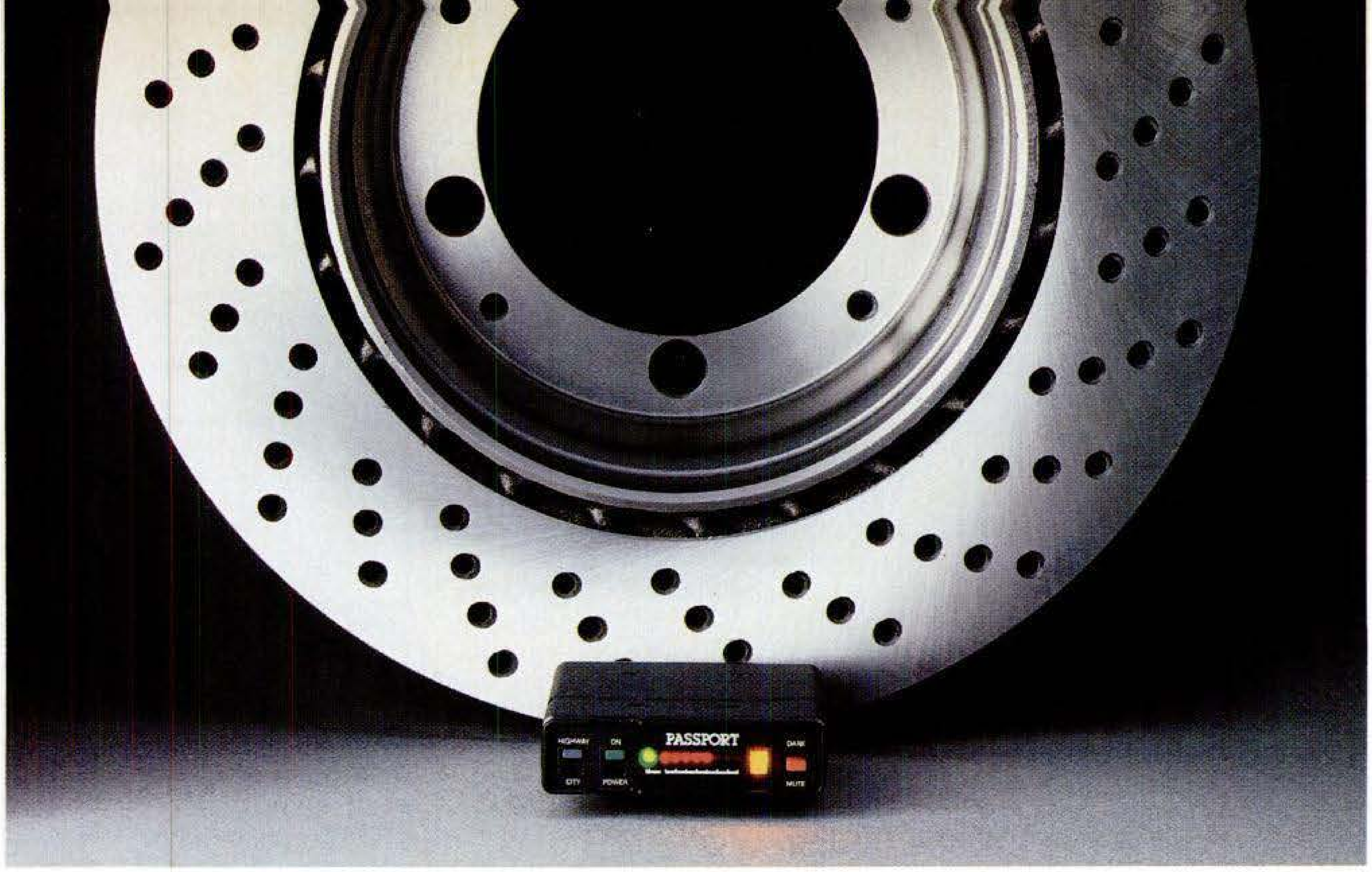
West Coast Editor: Jim Schefter
European Editor: David Scott

Editorial Assistants: Adeline Hooper *Chief*, Raymond A. Marcus, Nancy Negovetich

Senior Production Manager: Henry W. Kazmirowski
Business Manager: Anna Dallas

CONSULTING EDITORS
Richard Day *Home & Shop*
R. J. De Cristoforo *Shop Techniques*
Robert Gannon *Science*
A. J. Hand *Tools*
Ben Kocivar *Aviation*
E. F. Lindsley *Outdoor Power Equipment*
Stephen Mercaldo *Auto Maintenance*
Everett H. Ortner *Photography*
Evan Powell *Appliances, Home Equipment*
Jim Schefter *Space*
Smokey Yunick *Auto Mechanics*

PHOTOCOPY PERMISSION: Permission is granted by Popular Science for libraries and others registered with the Copyright Clearance Center (CCC) to photocopy articles in this issue for the flat fee of $1 per copy of each article or any part of an article. Send correspondence and payment to CCC (21 Congress St., Salem, Mass. 01970); specify CCC code 0161-7370/85/$1.00 + 0.00. Copying done for other than personal or reference use without the written permission of Popular Science is prohibited. Address requests for permission on bulk orders to Chief Editorial Asst., Popular Science, 380 Madison Ave., New York, NY 10017.



Small Wonder

It's here, *pocket-size* radar protection.

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slide into a shirt pocket, beautiful enough to win an international design award.

Small means nearly-invisible protection

That could only be PASSPORT. It has exactly what the discerning driver needs, superheterodyne performance in a package the size of a cassette tape.

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedented in radar detectors. It's no surprise that such a superlative design should be greeted by superlatives from the experts.

"In a word, the Passport is a winner," said *Car and Driver.*

Small means the size of a cassette tape

The experts report excellent performance. Simply switch PASSPORT on and adjust the volume knob. Upon radar contact, the alert lamp glows and the variable-pulse audio begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

As you get closer, the pulse quickens and the bar graph lengthens. Should you want to defeat the audible warning during a long radar encounter, a special switch provides silence, yet leaves PASSPORT fully armed for the next encounter. A photocell adjusts alert lamp brightness to the light level in your car. PASSPORT was designed for your protection *and* your convenience.

In PASSPORT, 102 SMDs (right) do the work of ordinary transistors, resistors and capacitors.

PASSPORT comes with a leather case and travels like a pro, in your briefcase or in your pocket—to the job for trips in the company car, on airplanes for use in far-away rentals. Just install on dashtop or visor, then plug into the lighter. PASSPORT keeps such a low profile. It can be on duty without anyone noticing.

Small means an easy fit in the briefcase

One more PASSPORT convenience—call us direct. It's toll free. We make PASSPORT in our own factory and we'll be happy to answer any questions you may have. If you decide to buy, we'll ship your PASSPORT within 24 hours by UPS, and we'll pay the shipping. For an extra $6.00, Federal Express guarantees 48-hour delivery.

If you're not satisfied within 30 days, return PASSPORT. We'll refund your purchase and your return shipping costs. There are no hidden charges.

Isn't it time for a PASSPORT of your own?

$295 (OH res. add $16.23 tax)
Slightly higher in Canada

VISA MasterCard

© 1986 Cincinnati Microwave, Inc.

PASSPORT®
RADAR · RECEIVER

Call Toll Free 800-543-1608
Cincinnati Microwave
Department 2160
One Microwave Plaza
Cincinnati, Ohio 45296-0100

Readers Talk Back *Continued*

a gasoline engine to power a generator, which in turn powered electric motors in the hub of each wheel. This eliminated the need for belts, chains, or a transmission. The car was built by 25-year-old Ferdinand Porsche with the help of Ludwig Lohner and was called the Porsche-Lohner Chaise. It was referred to as a "Mixit" and nicknamed "Aunt Eulalia."

Steven Glaze, Regina, Sask.

Solar subsidies

The Sun-Powered Subdivision section of "Innovative Homes: A Portfolio" [Aug.] paints a misleadingly rosy picture. There are two important subsidies involved in this situation. First is a law that requires the local utility to buy excess electricity from the subdivision. This is, in effect, transferring the burden of storing electricity for use at night and on cloudy days to the local utility in order to have a completely independent solar-powered unit. Second, because the "micro-utility" was financed by tax credit, the burden of paying for it was transferred to taxpayers in general and not to the homeowners. I think it is far past the time that all subsidies to energy generation and conservation were eliminated so that research efforts could be concentrated on economically feasible methods, not on cultivating subsidies.

John R. Ledbetter Jr.
Rogersville, Ala.

Canada towers over Texas

Your August article "Texas-Sized Eggbeater" surprised me. In it you say that the proposed 164-foot-tall 500-kilowatt wind machine will be the "largest eggbeater windmill yet." A 4,000-kilowatt vertical-axis wind turbine is presently being built on the Gaspé Peninsula in eastern Quebec. The two-bladed machine, named "EOLE" after the Greek god of the winds, will be 210 feet in diameter and will stand 360 feet tall. Construction is expected to be finished this fall. Sorry, but this time the largest in the world will be in Canada.

Louis Marmen, Solar Energy Div.
Energy, Mines and Resources Canada
Ottawa, Ont.

Customizing gutters

Your article on installing vinyl gutters [Aug.] is surely a finger and frustration saver. As a home designer I would add a couple of ideas: On a gabled house, omit the downspouts and leave gutter ends open. This reduces both cost and work. As water is carried away from the house, leaves and debris tend to flush themselves out. On hip-roofed houses, use the usual outside corner fittings, but in each one cut a vertical three-by-two-inch opening from the bottom up, opposite the longer gutter run.

Earl M. Hill, Dowagiac, Mich.

Tireless Japanese

In reference to "High Rollers" [Aug.], the dimensions and specs pages show that Honda uses Michelin tires on the Acura Legend. With all the advances the Japanese have made in cars, cameras, and you name it, it's surprising they don't have a first-rate tire of their own to put on the Legend!

Jack Vann, Hilliard, Fla.

Shortsighted panelists

I have followed your panel-projects series since its inception. It has always been very interesting, the results intriguing. Therefore I am amazed at your statement in the August issue that "to continue the contest would risk repetition." That is the attitude once held by the U.S. Patent Office in the late 1800s. They proposed to close because everything that could be invented had been.

Roy A. Norman, Brunswick, Ga.

Hot topic

In regards to foil radiant barriers [Aug.], what is their effect on the durability of conventional asphalt and fiberglass shingles?

James W. Horton, Oak Ridge, Tenn.

Philip Fairey of the Florida Solar Energy Center replies: "Our tests indicate that the color of roofing shingles makes a far more substantial difference in shingle temperature (and, therefore, in the durability of asphalt shingles) than does the use of attic radiant-barrier systems. The durability of fiberglass shingles is not affected by temperatures encountered on a rooftop."

Corrections: In the tip labeled Rough-Riding Solution in July's "Taking Care of Your Car," the next-to-last sentence should read: "Then, using a hand pump, apply 15 inches of mercury to the PCV tube."

A zero was left out of the square footage of the Dutch fold-up home mentioned in the August New Housing Technology section. It should read 930 square feet. PS

Popular Science

GRANT A. BURNETT *Publisher*
JAMES M. GABAL *Advertising Director*

ADVERTISING OFFICES

NEW YORK
380 Madison Ave., New York NY 10017 (212) 687-3000
Todd Hammer, Robert L. Leichter, Frank Marshall,
Geoffrey Marshall, Ellen Saracino,
Harry Fleischman *Promotion Manager,*
Yvonne King *Make-Up Manager,* Marcus Barlow *Assistant,*
Mary Ansbro *Classified Advertising Director,*
Amy Petryk *Assistant to Publisher,*
Brenda Charles, Martha Frias

CHICAGO
875 N. Michigan Ave., Chicago IL 60611 (312) 337-7717
Jim King *Manager,* Ed McGoldrick, Gary Redmond,
Susan Hurthel

WEST COAST
3550 Wilshire Blvd., Los Angeles CA 90010 (213) 380-1936
Jacqueline Donnelly Kelly *Manager,* Theodore L. Henry,
Theresa Thum

SOUTHWEST
16990 Dallas Pkwy., Suite 220, Dallas TX 75248 (214)
380-0416
Joe T. Kelly & Associates
Joe Kelly, Harry Weiss

DETROIT
755 W. Big Beaver Rd., Suite 420, Troy MI 48084
(313) 362-9005
Edward A. Bartley *Manager*

Times Mirror
Magazines

Published monthly by
TIMES MIRROR MAGAZINES, INC.
380 Madison Avenue, New York N.Y. 10017
ISSN 0161-7370

HERBERT K. SCHNALL *Chairman of the Board*
ANDREW J. DEMPSEY *President*
JOHN CONDON *Executive Vice President, Administration*
JAMES KOPPER *Executive Vice President/Group Publisher*
MICHAEL HAUGH *Vice President and Treasurer*
GERTRUD BORCHARDT *Vice President, Manufacturing*
WILLIAM H. HUNTTING JR. *Research Director*
JAMES M. GIRALDEZ *Promotion Director*
DEB LEES *Marketing Director*

SUBSCRIPTION SERVICE

☐ New ☐ Renewal
☐ Change of address

☐ 1 YR. $13.94 ☐ 2 YRS. $24.97
☐ 1 YR. (Canada and Foreign) $17.94

☐ Payment enclosed ☐ Bill me later

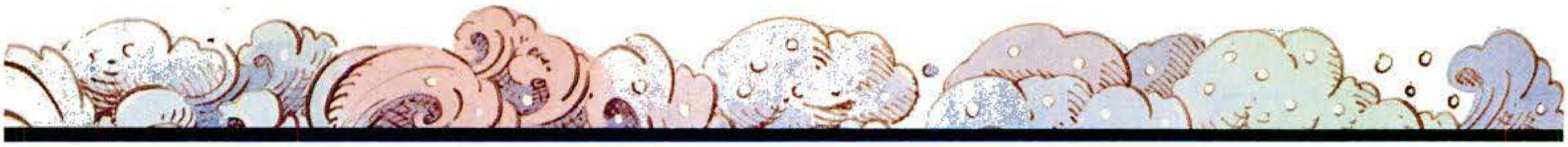
Please attach your mailing label from the front cover when writing about service or a change of address. If you are moving, place your mailing label in this space and write your new address in the space provided below. Allow 6 weeks advance notice.

(PLEASE PRINT)
NAME
ADDRESS
CITY
STATE
ZIP CODE

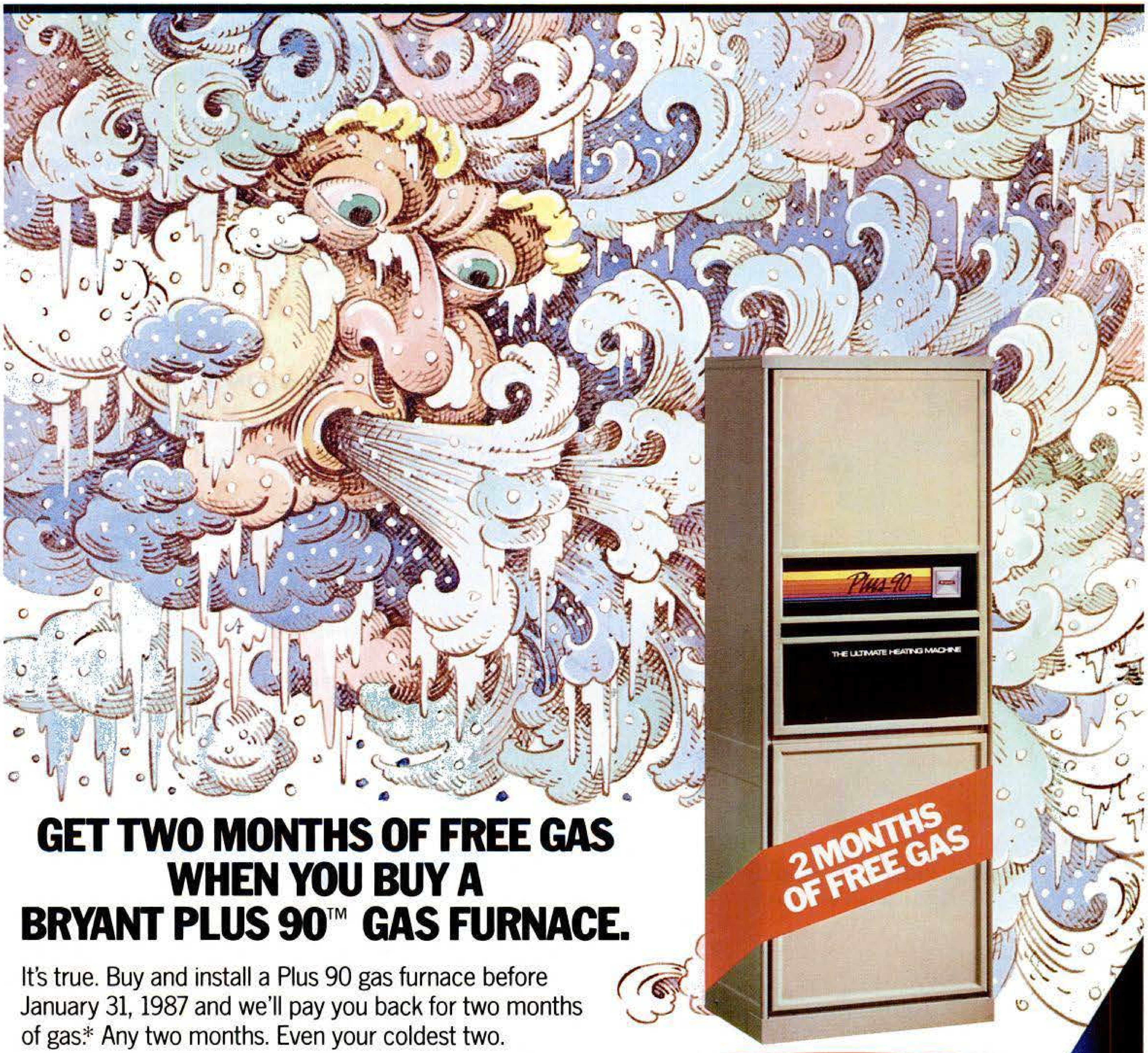
Occasionally we make our mailing list available to reputable organizations whose products or services may be of interest to you. If you'd like your name removed from this list, please check the box below.

☐ Please remove my name from your list.

Mail to: **POPULAR SCIENCE**
P.O. Box 2571
Boulder, CO 80302



HOW TO TAKE THE BITE OUT OF WINTER:



GET TWO MONTHS OF FREE GAS WHEN YOU BUY A BRYANT PLUS 90™ GAS FURNACE.

It's true. Buy and install a Plus 90 gas furnace before January 31, 1987 and we'll pay you back for two months of gas.* Any two months. Even your coldest two.

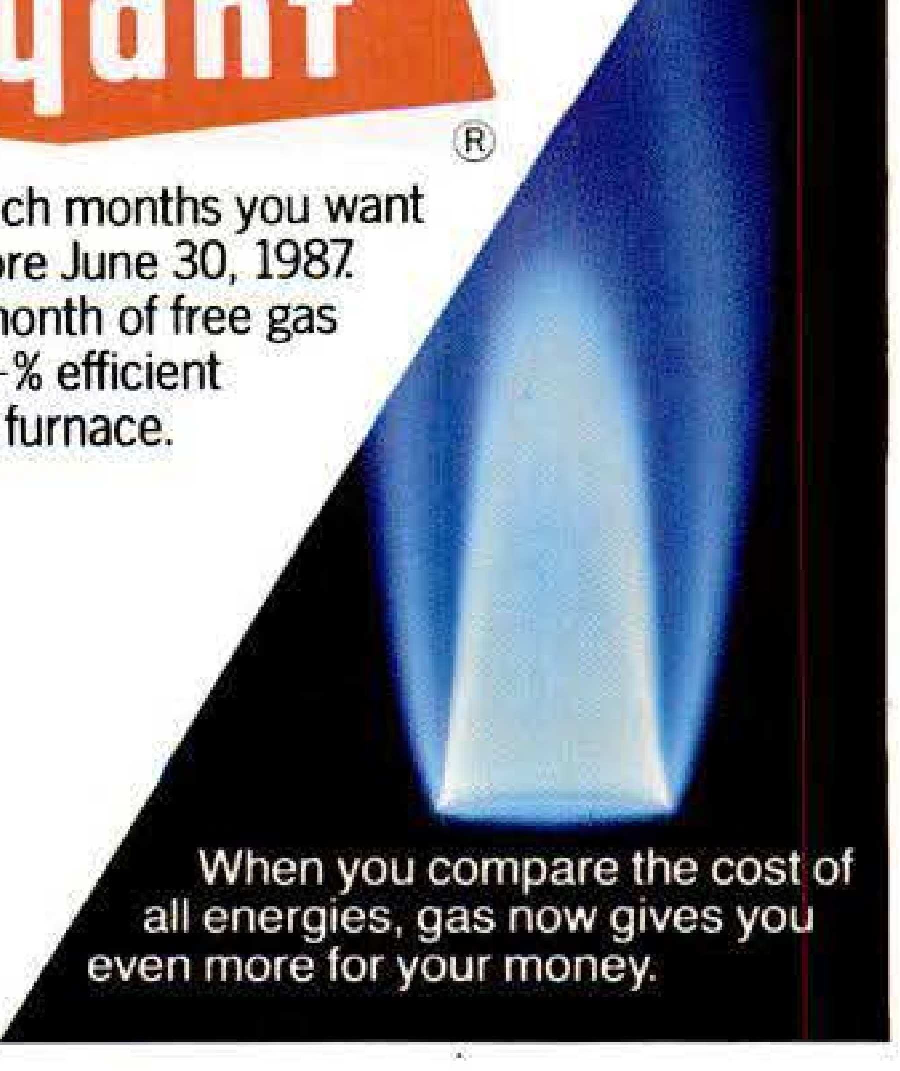
And that's not all you'll save. The combination of clean gas—your most economical way to heat—and Bryant high-efficiency can cut hundreds of dollars off your gas bills. So you save big now. And for years to come.

Call 800-HOT-SALE for your participating dealer. And let winter do its worst. Because no matter how cold it gets, you'll stay warm and comfortable at a fraction of your normal cost.

bryant®

*Choose which months you want free gas before June 30, 1987. Or get one month of free gas with our 80+% efficient *Formula* gas furnace.

CALL 800-HOT-SALE



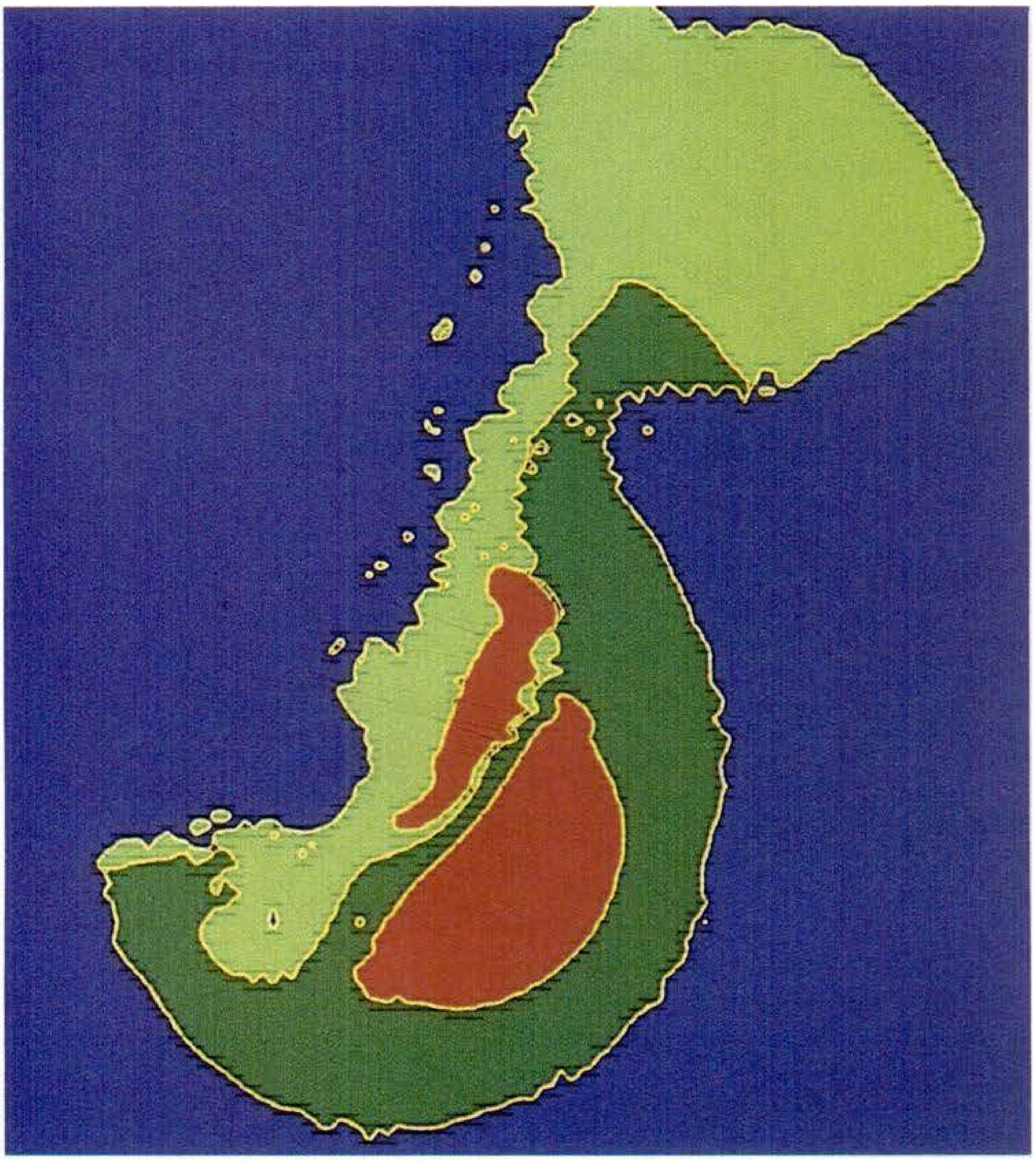
When you compare the cost of all energies, gas now gives you even more for your money.

Gas. America's best energy value.

©1986 American Gas Association

Science Newsfront

By ARTHUR FISHER



Formation of the moon follows an Earth-planet collision in this simulation.

Moon birth

What is the origin of the moon? The question has been debated endlessly by astrophysicists and planetologists. The grab bag of moon rocks brought to Earth by Apollo astronauts disappointingly failed to resolve the issue, leaving in place a number of contending theories.

Now one of those theories, scorned by most experts when it was first put forth in the mid-1970s, is gaining support. Called the giant-impact theory, it says the moon was born of a monstrous collision between a primordial, just-formed Earth and a protoplanet the size of Mars.

Much of the evidence for the theory comes from modeling such a collision on powerful supercomputers to see whether there is a fit between this scenario, the laws of physics, and the present nature of the Earth-moon system. Computer simulations run by two teams of scientists—one at Los Alamos National Laboratory, the other a collaboration between Sandia National Laboratories and the University of Arizona—give the giant-impact idea great plausibility.

The photo shown here is from a sequence created by H. J. Melosh of the University of Arizona's Department of Planetary Sciences and M. Kipp of Sandia. The time is 4.6 billion years ago, during Earth's accretion from the swarm of planetesimals surrounding the sun, just after the formation of the solar system itself. Earth has been struck a glancing blow, about 20 minutes before, by a projectile about the size of Mars traveling at 7.4 miles per second.

From the intersection of the two bodies, a jet of vapor at about 12,000 degrees F spurts out. The head of the plume is composed of vaporized projectile mantle. (Red colors denote the metallic iron-nickel cores of both bodies; green denotes their silicate mantles.) The head of the plume is moving so fast that it exceeds escape velocity and leaves Earth for good. The neck of the plume, consisting of a mixture of half Earth and half projectile mantle material, eventually condenses into pebble-size rock fragments that orbit Earth. Gravitational attraction ultimately fuses this cloud of pebbles into the moon.

This scenario dovetails neatly with what is known about the moon's chemistry. It is very dry and lacks volatile metals, such as potassium and cesium, because only the more refractory elements can condense from a hot gas cloud as it cools in space. And the moon's average composition should resemble Earth's because about half of its matter comes from Earth rocks—a prediction confirmed by an analysis of moon rocks.

On the Wing a zinger

If you live anywhere near one of the 10 or so museums around the country that should by now be playing *On the Wing* in their Imax theaters, I urge you to see this remarkable film. It is by far the best of the series of giant-screen spectaculars on the theme of flight or transportation. Among the goodies: Paul MacCready's flying replica of a pterodactyl, captured in realistic swoops and soars over a prehistoric-looking gorge; authentic re-creations of the Wright brothers' flights; and a genuinely breathtaking aerial duet featuring a hang glider and a golden eagle.

Magnetic-field record

Researchers led by Lawrence G. Rubin at Massachusetts Institute of Technology's Francis Bitter National Magnetic Laboratory have created the world's most powerful magnetic field, some 700,000 times stronger than Earth's. The new record, 33.6 tesla, surpasses a previous record, 30.7 tesla, set earlier this year by a group in Japan. It was achieved with a hybrid design: a superconducting magnet surrounded by a copper magnet that acts as a field concentrator.

Ultra-high magnetic fields are important tools used in probing the behavior of superconductors, semiconductors, and magnetic materials.

Continued

FILTER CIGARETTES
Marlboro
Marlboro

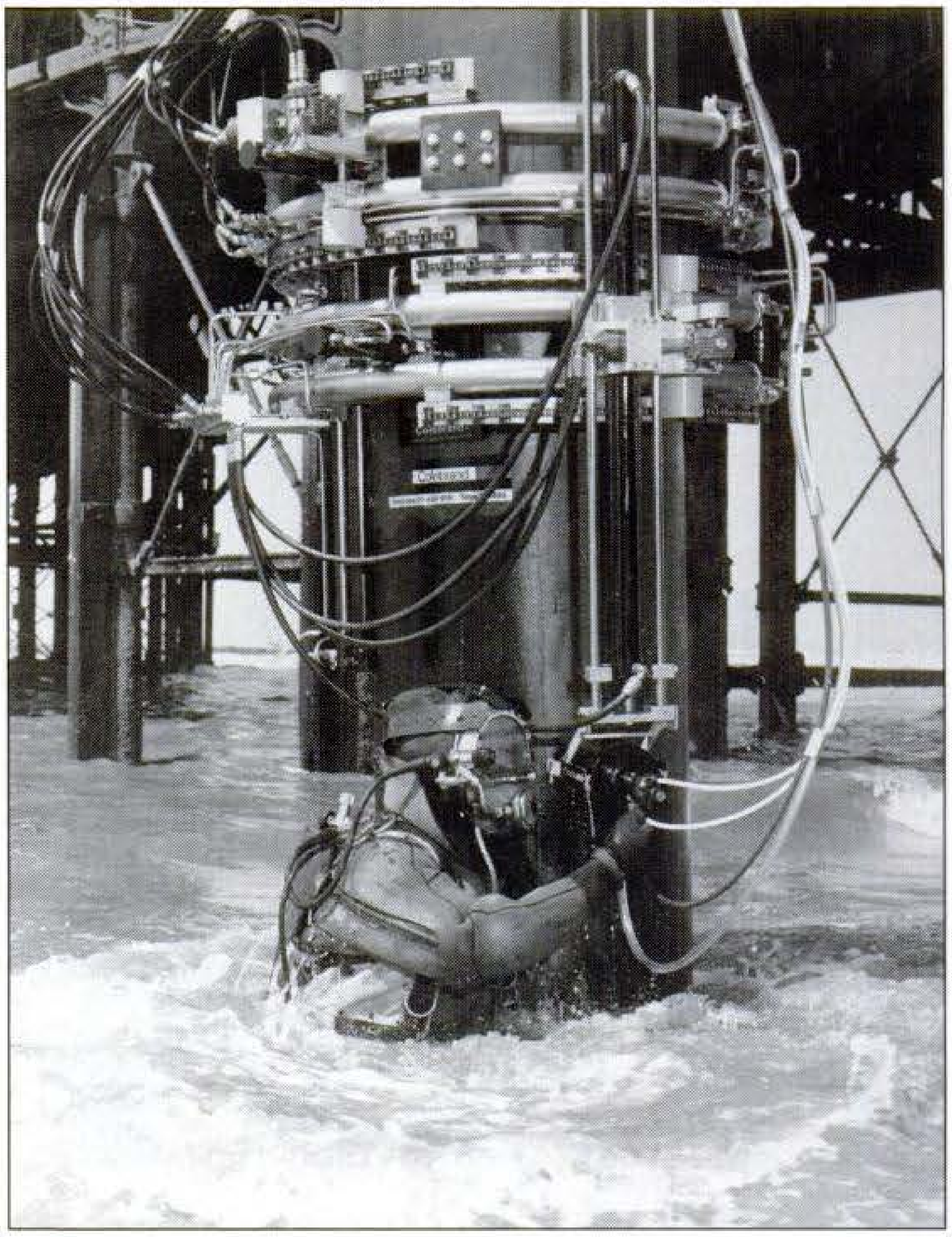
SURGEON GENERAL'S WARNING: Cigarette Smoke Contains Carbon Monoxide.

© Philip Morris Inc. 1986

16 mg "tar," 1.0 mg nicotine
av. per cigarette, FTC Report Feb.'85

LIBERTY
IN GOD WE TRUST
1983

Microsensor monitors radiation doses for cancer therapy.



CUPS underwater painting system uses compressed-air jets.

Pure oxygen no fix

All those exhausted football players sucking oxygen on the sidelines could just as well save their collective breath, according to a recent study at the University of Texas Health Science Center at Dallas. Dr. Peter Snell, co-director of the Human Performance Center there and a three-time Olympic gold medalist to boot, says a controlled test of athletes showed there was no difference in how well or how quickly the subjects revived whether they breathed 100-percent oxygen or just plain undoctored air. Biggest surprise: They couldn't even accurately guess which was which.

Radiation sensor

The tiny device at the tip of the medical catheter in the photo above is a miniature radiation sensor, originally developed at Sandia National Laboratories for use in nuclear weapons. Now it has been adapted as a dosimeter, able someday to monitor the doses received by cancer patients undergoing radiation therapy. The heart of the device is a RADFET—radiation-sensing field-effect transistor—that is less than one millimeter in diameter. Sandia researchers developed a means of mounting it inside a standard catheter that is 0.88 millimeter in diameter (just over 0.03 inch) and is commonly used to implant radioactive pellets in certain cancer patients. The dosimeter was developed by Drs. Robert C. Hughes of Sandia and Charles A. Kelsey of the University of New Mexico Cancer Center. It has undergone extensive testing at both institutions.

Farthest quasar

A team of astronomers headed by Cyril Hazard of the University of Pittsburgh has made a far-reaching discovery—the most distant object ever to be observed. The new find is a quasar (short for quasi-stellar radio source) that is some 12.4 billion light-years from Earth, about 10 million light-years farther than the most distant quasar previously observed. "A study of the most distant quasars," says Hazard, "can let us look back in time to the early history of the cosmos and tell us a great deal about the origins of the universe."

Unique semiconductor

Three engineers at the University of California, Los Angeles, have developed a semiconductor made of thin layers of beta silicon carbide that promises, according to their report, "a significant breakthrough in the size, power, speed, operating temperature, and radiation resistance of solid-state-semiconductor devices and integrated circuits." The material can function at a temperature of about 2,200 degrees F, much higher than current semiconductors, making it especially valuable for jet engines, power plants, and the deep drilling equipment used in mineral and geothermal exploration. And its high resistance to radiation should make it a candidate for deep space probes penetrating radiation belts.

The new device was developed by Rointan F. Bunshah, Oscar M. Stafsudd, and James D. Parsons. It has been patented by UCLA and licensed to the Hughes Research Laboratories.

Painting down under

Underwater, that is. The elaborate contraption in the photo above is an automatic underwater painting system that can, under certain conditions, do away with the need for a diver. It works by forcing compressed air into a shield surrounding the work surface. The air displaces water, and paint is then sprayed under high pressure into the air pocket and onto the surface to be covered. The system, called CUPS, is made by Colebrand Ltd. of London, England. PS

New Jeep Comanche SporTruck

$6495.*

AND IT'S ALL JEEP.

1987 COMANCHE SPORTRUCK: It's not only the newest 2-wheel drive Comanche pickup, it's also the most affordable vehicle Jeep builds. At just $6,495, SporTruck has the most powerful standard engine of any truck in its class... delivering an impressive 121 horsepower. Plus, it's the only vehicle in its class with big 15-inch wheels and tires, standard.

POWER: This year, Comanche comes with an all-new optional 4.0 litre *Power-Tech Six* engine that puts out 173 horsepower and 220 foot-pounds of torque. That makes Comanche by far the most powerful truck of its kind.

A WIDE RANGE OF VEHICLES: Comanche gives you the choice of two-wheel drive or shift-on-the-fly four-wheel drive. And you can choose between the new shortbed model or longbed with the largest optional 4-wheel drive payload capacity of any truck in its class.

OTHER OPTIONS: Comanche already has a lot going for it. And there's a long list of available equipment that includes a responsive new 4-speed automatic transmission with overdrive.

Check out the new SporTruck and all the other Comanche pickups. It's the kind of truck just about anybody can afford. But it's also the kind of truck only Jeep can build.

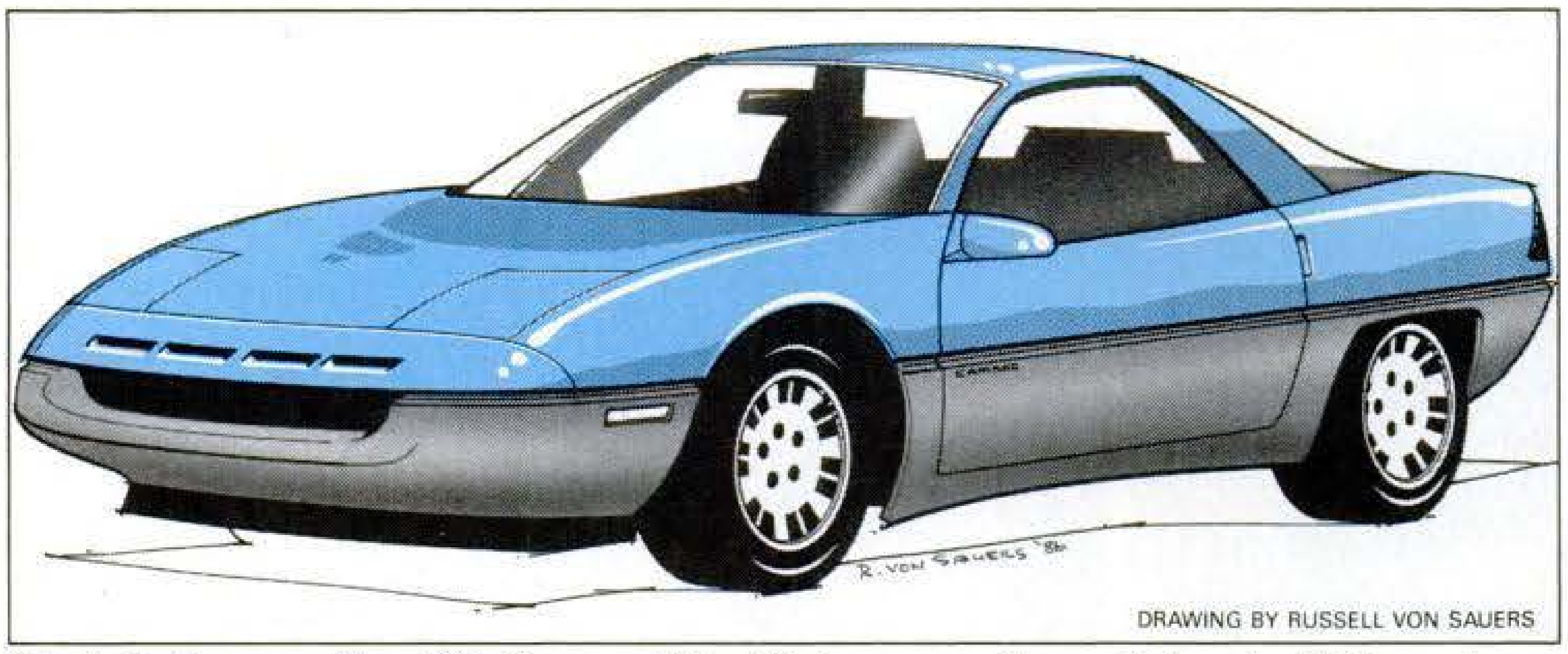
*$6,495. Manufacturer's suggested retail price. Title, taxes and destination charges, and options are extra. Price may change without notice.

Safety belts save lives.

Jeep Comanche
Available in 2WD and 4WD

Automotive Newsfront

By DAN McCOSH
Detroit Editor



DRAWING BY RUSSELL VON SAUERS

Sleek but expensive: '91 Camaro/Firebird was postponed due to high cost.

Once and future Camaro

The latest word from Detroit is that the sleek front-drive sports coupe pictured above—a nearly finalized design for the 1991 Chevrolet Camaro and Pontiac Firebird—has been postponed indefinitely, putting on hold one of General Motors' most radical advanced development programs.

Planned as the first high-volume plastic-bodied car, the sports coupe (known in the industry as the GM 80) was expected to break new ground in the use of composites. With its 200-horsepower V6 driving the front wheels through a viscous limited-slip differential, it also was expected to be one of the most powerful front-drive cars yet. And unlike today's Camaro and Firebird, Chevy and Pontiac versions of the car were to be distinctly different.

Advanced engineering at GM has been concentrating on composites for future cars, partially because of advantages such as corrosion resistance, but also because plastics seem to offer a way to drastically reduce manufacturing costs. Ironically, the high cost of the GM 80's hybrid steel-and-plastic design may have scuttled it.

The GM 80 had been designed with a steel structural frame, to be covered by molded plastic panels. It was to be similar to the current Fiero, but development work was aimed at simplifying the steel cage used as a frame. Alternatives studied for the GM 80 included an extruded aluminum frame, a tricky rolled-steel tubular structure, and an all-fiberglass frame.

Planned volume for the new Camaro and Firebird was about 350,000 cars per year, about three times that of the Fiero. This would have been a major step toward GM's goal of building 20 percent of its cars with plastic bodies. Also, the four-seat GM 80, with its 96-inch wheelbase, would have been the largest car yet with a Fiero-style structure.

But insiders said GM had to avoid pushing the price of its sporty cars into the stratosphere. And studies indicated that for the GM 80 the steel frame alone would have cost nearly as much as a conventional all-steel body-and-frame assembly. Problems handling the high torque of the V6 in a front-drive car also were anticipated. These could have been cured with four-wheel drive, but again at considerable cost.

So it's back to the drawing board, at least temporarily, for the next decade's Camaro and Firebird. Current discussion about the next-generation car centers on a short, aggressive-looking rear-drive design that could yet incorporate four-wheel drive for high-horsepower versions.

Problems with the GM 80 program have hardly dampened GM's enthusiasm for composite car construction, though. Work is proceeding on an all-plastic car that would eliminate the costly steel frame altogether by using a molded, bonded chassis that would bypass most conventional assembly steps.

Wireless progress

The aggravation quotient of today's gadget-laden automobiles is sometimes proportional to the miles of wires and hundreds of connections needed to keep all the electronics working. Hence, the growing interest among engineers in eliminating some, if not all, of this complex wiring.

One answer is multiplexing, whereby electrical accessories like window lifts become self-contained "smart" systems that decode signals from a central computer, then execute its commands. Such systems already have eliminated miles of wires in aircraft, but at a price far too high for the family car.

The rapidly dropping cost of high-amperage switching circuits is drawing interest among engineers working on making multiplexing practical. United Technologies is working on a smart motor, a relatively simple electric motor that responds directly to computer commands. And Chrysler and Allied-Signal just bought part of Synektron Corp., a Portland, Ore., maker of computer disk-drive motors that incorporate smart circuitry. The deal includes the right to use Synektron's technology for automotive motors.

Such pieces ultimately will become part of electromechanical systems interconnecting all basic control circuits of a car. GM has its own engineers and aerospace systems analysts from its latest acquisition, Hughes Aircraft, working on something called "Project Trilby," a study of the potential for substituting electronic systems for today's essentially mechanical components.

All of this may be of little comfort to tomorrow's stranded motorist. Once able to fumble around in the dark and replace a blown fuse, he or she may be confronted instead with problems like a snapped optical fiber connecting two of the car's computers.

Curing air-conditioning lag

Small-displacement engines often have to struggle with the air-conditioning compressor, resulting in annoying surge and vibration as the compressor cycles on and off to maintain temperature. Now GM is phasing in a clever variable-displacement compressor that smoothly adjusts refrigerant flow rather than constantly switching on and off.

The compressor has five cylinders in a rotary arrangement, something like the design of a five-shot revolver. Pistons are driven up and down by rods attached to a tilted disc that rotates on the compressor shaft. Refrigerant pressure in the system controls the tilt of the plate. Less tilt means a shorter piston stroke and less compressor displacement.

Continued

AIR
NATIONAL
GUARD

NOW HIRING.
PART-TIME.
UP TO $27,000.

Air National Guard, P.O. Box 6000, Clifton, NJ 07015

NAME ☐ MALE ☐ FEMALE
(Please Print)

ADDRESS

CITY STATE ZIP

PHONE BIRTHDATE

OCCUPATION

A2PSTA**106NP

© 1985 UNITED STATES GOVERNMENT AS REPRESENTED BY THE SECRETARY OF DEFENSE. ALL RIGHTS RESERVED.

Here's the deal.

You agree to serve with us two days a month and 15 days a year.

And you may qualify for up to $27,000 in educational benefits and bonus money. All on top of your regular Guard pay.

Just pick from a special group of technical fields that includes communications, electrical power production, munitions loading, surgical services, fire protection and more.

Train to work in critical specialties. And, depending on the specialty you choose, you may qualify for up to $27,000 in benefits.

Plus, you'll pick up skills you may use to land a civilian job right now.

To find out if you qualify, contact your local Air Guard recruiter, call **800-638-0936***, or cut out the attached coupon. And cut yourself in for as much as $27,000 in benefits. In the Air National Guard.

*In New Jersey, Alaska, Puerto Rico, Guam, Hawaii, and the Virgin Islands, consult your local directory.

Programs, Eligibility Requirements, and Amounts are subject to change without notice.

Air National Guard

AIR
NATIONAL
GUARD

Americans At Their Best.

Copyrighted material

Born in California: FX16 has four-valve engine and "Made in U.S.A." label.

Intriguing in these days when electronics controls nearly everything in the car, the variable-displacement compressor uses a mechanical control—a simple bellows that responds to pressure changes.

California screamer

Toyota officially joins the "Made in the U.S.A." contingent with the Corolla FX16 pictured above. Built at the New United Motors Manufacturing Inc. (NUMMI) plant in Fremont, Calif., the tiny hatchback sports a 1.6-liter four with a four-valve cylinder head, electronic fuel injection, four-wheel disc brakes, and Goodyear Eagle VR series tires.

NUMMI, a joint venture between Toyota and GM, also builds the Chevrolet Nova. Word from Chevy is that one version of the Nova also will get the smooth, high-revving four-valve engine—but not until at least 1988.

Almost a Cobra?

Ford's GN 34 high-performance mid-engined sports-car program, which is expected to result in a production car in the late 1980s, has spawned a variety of early prototypes. The example shown below appears to be one step beyond a sleek show car Ford unveiled last winter called the Cobra 230 ME. The spy photo shows some refinements, mainly in the side trim and in the elimination of the ladderlike airfoil that covered the rear window of the show car.

The Cobra 230 ME is powered by a 300-horsepower turbocharged four-cylinder engine. But Ford has held chassis and drive-train details of the actual GN 34 close to its chest. Best guess is that it will be a new V6, possibly one of several modular engines that Ford would produce in different cylinder configurations.

With a price anticipated to be in the mid-$30,000 range, Ford's Corvette fighter would be in the upper reaches of the sports-car market. Ford engineers prefer to think of the cost of the GN 34 as "less than half the price of a Ferarri."

Gas pains

How did General Motors Corp., with its hundreds of test cars and millions of miles of durability driving, fail to predict fuel-injector-clogging problems that have plagued late-model cars? Joseph J. Colucci, who heads the fuels and lubricants department at GM research, said the problem simply slipped through the test procedure. The deposits form when a hot engine is shut down, baking carbon and varnish onto the tips of injectors. But the engines used for durability testing are rarely turned off. "The problem didn't show up in mileage-accumulation tests because they just rack up the miles," Colucci said.

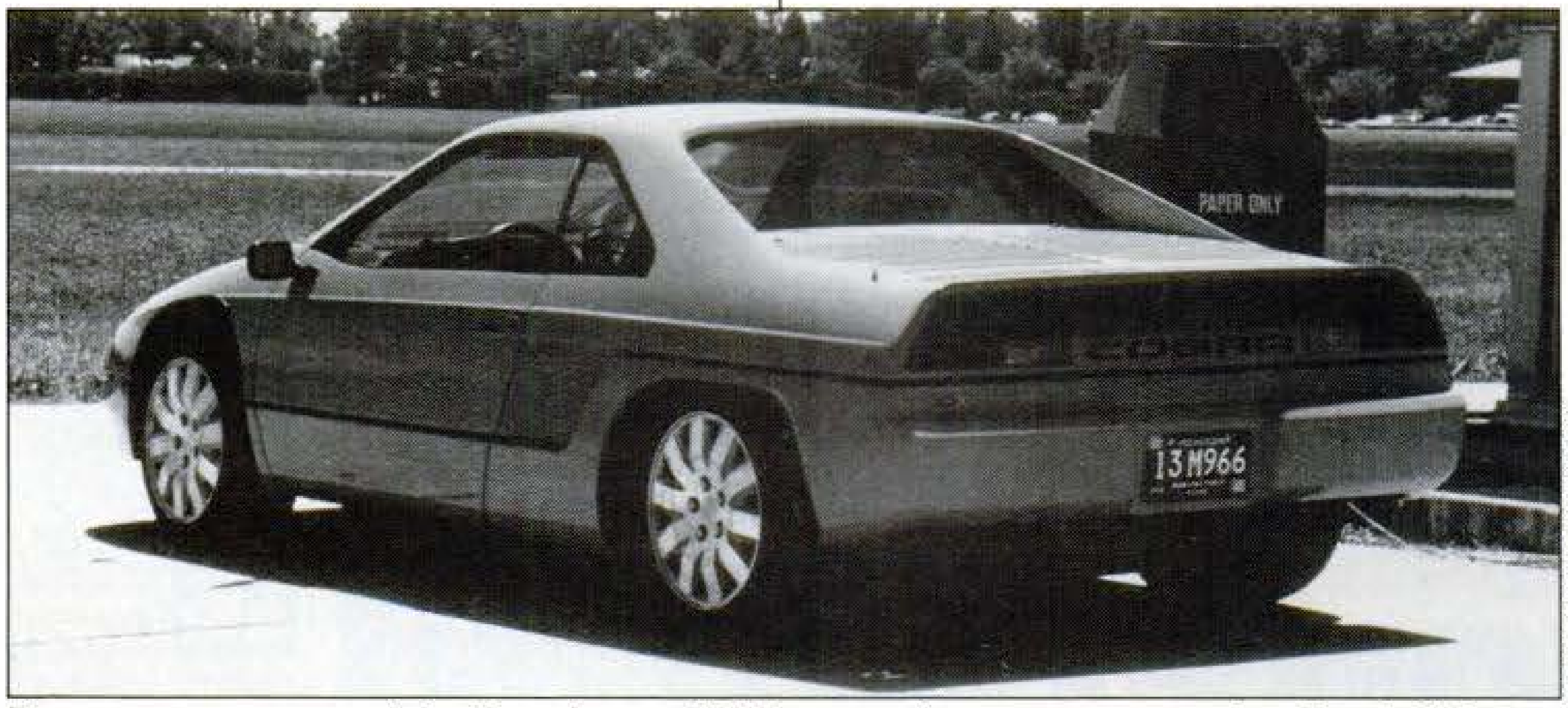


PHOTO BY TOM WILKINSON

Two-seater snapped in Dearborn, Mich., may be a prototype for Ford GN 34.

GM contends that more detergent in gasoline is the answer. Colucci told writers at an International Motor Press Assn. meeting in New York that GM will take the unusual step of issuing a bulletin to dealers recommending that customers buy gas from companies that advertise high detergent levels. He said severely clogged injectors also can be flushed with solvent at a dealer or repair shop.

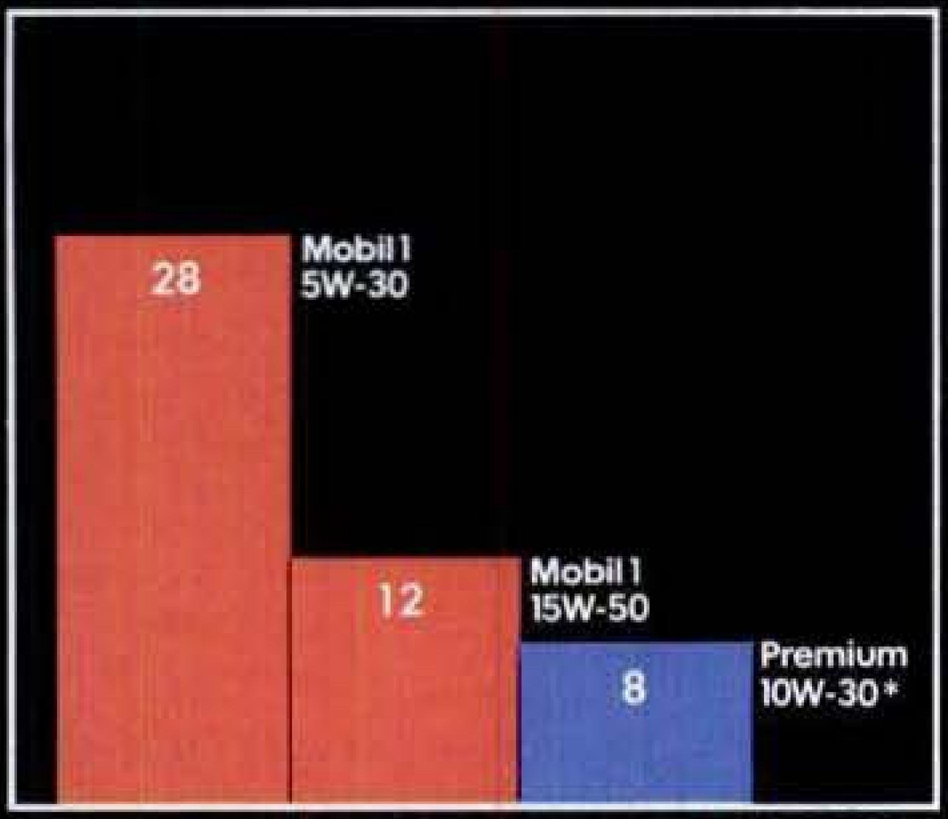
Meanwhile, GM's own Rochester Products Division, Bendix, and Toyota are introducing clog-resistant injectors. Colucci said that Bosch, which currently dominates the injector business, would do likewise.

News briefs

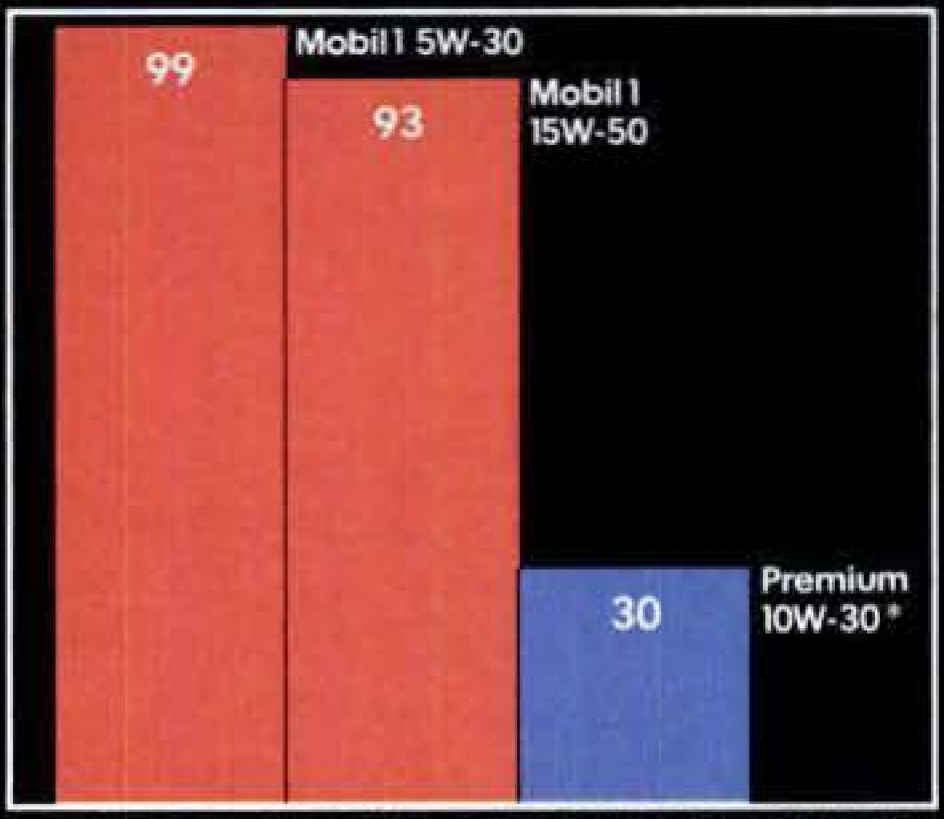
- Searching for one of those elusive special tools that factory repair manuals are always referring to? Kent-Moore sells through the mail just about every special tool imaginable for domestic and imported vehicles, as well as a complete selection of other tools, meters, and analyzers. They're proud of it, too—the catalog is called "The Best," and you can get one by writing America's Tool Store, Kent-Moore, Dept. 3191, 29784 Little Mack, Roseville, Mich. 48066-2298.
- Wretched excess department: Sports cars have gotten so fast that European tire makers have been forced to develop another speed rating. The old "V" rating, which used to designate tires for cars capable of speeds over 130 mph, is now capped at 149 mph. Tires for cars *faster* than this now will be rated "Z."
- Honda recently launched a series of high-output twin-cam V4s for motorcycles that use gears rather than cogged belts or chains to drive the camshafts. Though gears are often used on racing engines, where accurate cam timing is critical and noise unimportant, Honda becomes one of the few builders of road engines to adopt them. The company says it licked the noise problem with a spring-loaded gear system. PS

Contributor: Tom Wilkinson (New York)

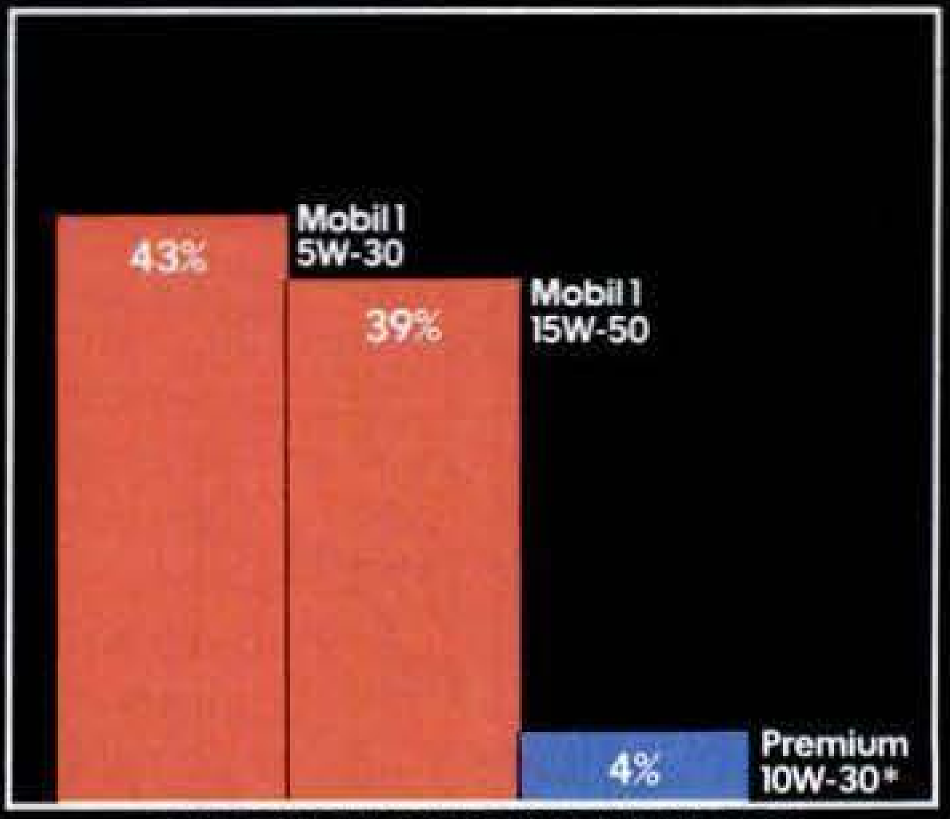
We gave Mobil 1 and premium 10W-30 oil a stress test.



COLD TEMPERATURE PUMPABILITY FACTOR

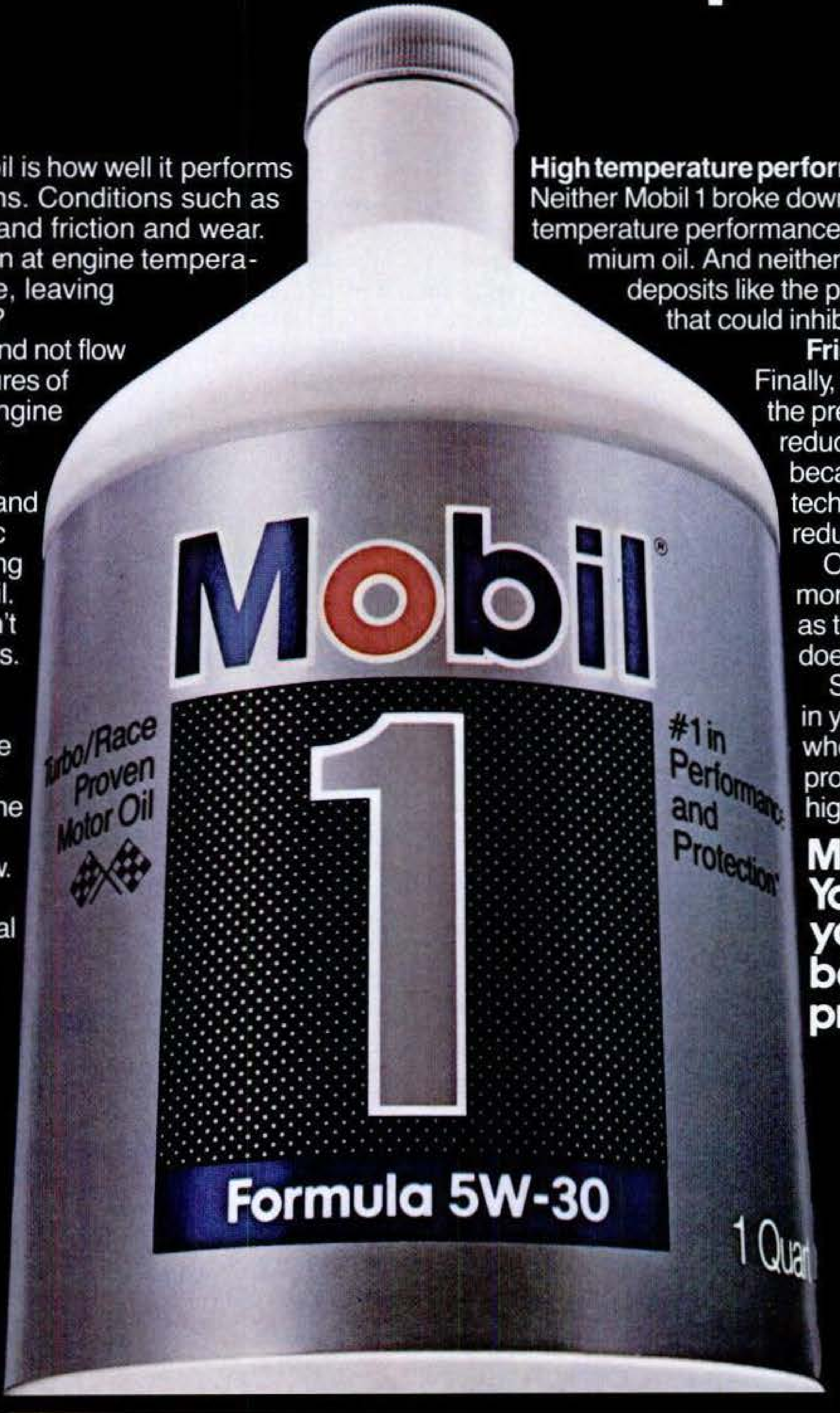


HIGH TEMPERATURE DEPOSIT PROTECTION
(100=CLEAN)



PERCENT FRICTION REDUCTION

The results weren't surprising.



A true test of a motor oil is how well it performs under stressful conditions. Conditions such as extreme heat and cold, and friction and wear.

Will the oil break down at engine temperatures of over 600° above, leaving harmful engine deposits?

Will the oil thicken up and not flow fast enough at temperatures of 13° below, leaving vital engine parts unprotected?

To find out, we tested Mobil 1® Formula 5W-30 and Formula 15W-50 synthetic motor oil against a leading premium 10W-30 motor oil. We must admit, we weren't at all surprised at the results.

Cold temperature performance.

In the cold temperature performance test, neither Mobil 1 thickened up like the premium oil. And both flowed faster at 13° below. This demonstrates that both Mobil 1's lubricate vital engine parts faster, so engines start easier and are protected better.

High temperature performance.

Neither Mobil 1 broke down in the high temperature performance test like the premium oil. And neither left harmful carbon deposits like the premium oil, deposits that could inhibit performance.

Friction reduction.

Finally, when compared to the premium oil in the friction reduction test, both Mobil 1's, because of their advanced technology, dramatically reduced friction.

Of course, Mobil 1 costs more than premium oil, but as the tests prove, Mobil 1 does so much more.

So put Mobil 1 to the test in your car. And remember, when it comes to engine protection, no other oil gets higher marks.

Mobil 1.
You can't give your car better engine protection.

*Texaco Havoline Supreme®

Also available in Formula 15W-50

©1986 Mobil Oil Corporation

"Say, Smokey—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Clunky drive train

I have a 1983 Dodge Ram 150 short-wheelbase pickup that clunks loudly when I pull to a stop or shift the truck from park to reverse or from reverse to forward. It also feels like the brakes are sticking when I pull away from a stop. I have changed the U-joints to no avail. The dealer says these problems are due to the angle of the drive shaft, and won't hurt anything. I have heard that all short-wheelbase Rams do the same thing, some worse than others.

Chuck Jumonville, Patterson, La.

I think it's the inability of the drive-shaft sliding yoke to move in and out freely. When torque is applied to the wheels, the axle winds up, and this changes its angle and the distance from it to the transmission. If the splines bind, they'll clunk. Lots of cars and trucks have this problem. The best cure I know is putting a lubricant coating on the drive-shaft splines and the bushings of the torque arms that control axle windup.

More rotten eggs

I recently purchased a Ford Taurus wagon with a three-liter V6 engine. I love the car, except for one thing: a terribly noxious odor of "rotten eggs" comes from the exhaust. What is it and how is it to be corrected?

Jean Wells, Lynn, Mass.

Sulphur in some gasoline is heated and condenses in the catalytic converter and muffler to cause this problem. Finding fuel with no sulphur is the best solution. Another fix is to route the tail end of the exhaust system so the fumes don't get sucked into the car when the windows are open. This is a pretty silly problem for owners to have to figure out for themselves.

Alcohol and carburetors

Does any or all unleaded gasoline contain alcohol? After he repaired the carburetor in my 1978 Buick Park Avenue, a mechanic said that alcohol in the unleaded gasoline I was using had damaged rubber parts in the accelerator-pump assembly. Do you recommend a particular gasoline for my car?

V. D. Widney, Watonga, Okla.

Alcohol may be found in any gasoline, but it should be marked on the pump. Ask questions before you buy. Improperly blended, methanol is bad in gasoline engines and can harm rubber parts, particularly when the content reaches more than 10 percent. Ethanol is not as bad, but still, in my opinion, it's not good for engines. Now that oil prices have dropped, it's getting easier to find pure gasoline again. In many areas you'll find gasoline companies advertising that their fuels contain neither methanol nor ethanol.

Low oil pressure

When I drive my 1985 Dodge Lancer in fifth gear at 1,600 to 2,000 rpm, the oil-pressure gauge reads little or no pressure. The dealer's mechanic says this is normal. I don't believe it. Do I have a problem? The car now has 11,000 miles on it and burns no oil.

Harold B. Sorenson
Chittenango, N.Y.

Have a direct-pressure type oil gauge temporarily installed in your car. If you have 10 psi of oil pressure for every 1,000 rpm of engine speed while running the recommended viscosity of oil, the system is in the ballpark. For example, at 2,000 rpm, you should read 20 pounds of pressure. If not, you have oil system trouble that needs quick attention.

Weak acceleration

I have a 1978 Ford Fairmont six-cylinder with a three-speed transmission. It is an excellent car with one exception: It doesn't accelerate well. It is as if the ignition advance were not working correctly; when you press the accelerator to the floor, the engine dies. If you press slowly, the car will take off. The Ford mechanic advanced the distributor until the the engine started to ping, and then backed off some. This helped, but the car still isn't right.

Harry Lawrence, Millerton, N.Y.

Some things to check for: a worn timing chain, a bad distributor-advance mechanism, or a weak accelerator pump. A cylinder leakage test is also good for checking the condition of the piston rings and valves. If the above are all right, there's something further to consider: The lack of performance you describe was often the result of efforts by the car companies during the period of passing exhaust-emissions regulations. A steeper ignition-advance curve and a camshaft that gives the engine more fuel, for example, would help performance—but making these modifications is illegal.

Engine miss

I have a 1983 Dodge Omni with a 2.2-liter engine and five-speed manual transmission. Several months ago it developed a miss or surge at moderate rpm that's most noticeable during normal acceleration. I've had it to two dealers who really don't know what the cause is. The carburetor has been rebuilt; the computer module, oxygen sensor, distributor pickup, cap, rotor, and spark plugs have been replaced; and the timing and carburetor have been adjusted. Got any ideas?

James Chester, Valparaiso, Ind.

I'd find a shop with a chassis dynamometer and check out the ignition and exhaust-gas readings at road speed, load, and rpm. The problem is bound to show up, probably in the ignition system. If the ignition and fuel systems read OK, that's your tip to look for a weirdo problem like a plugged-up exhaust system.

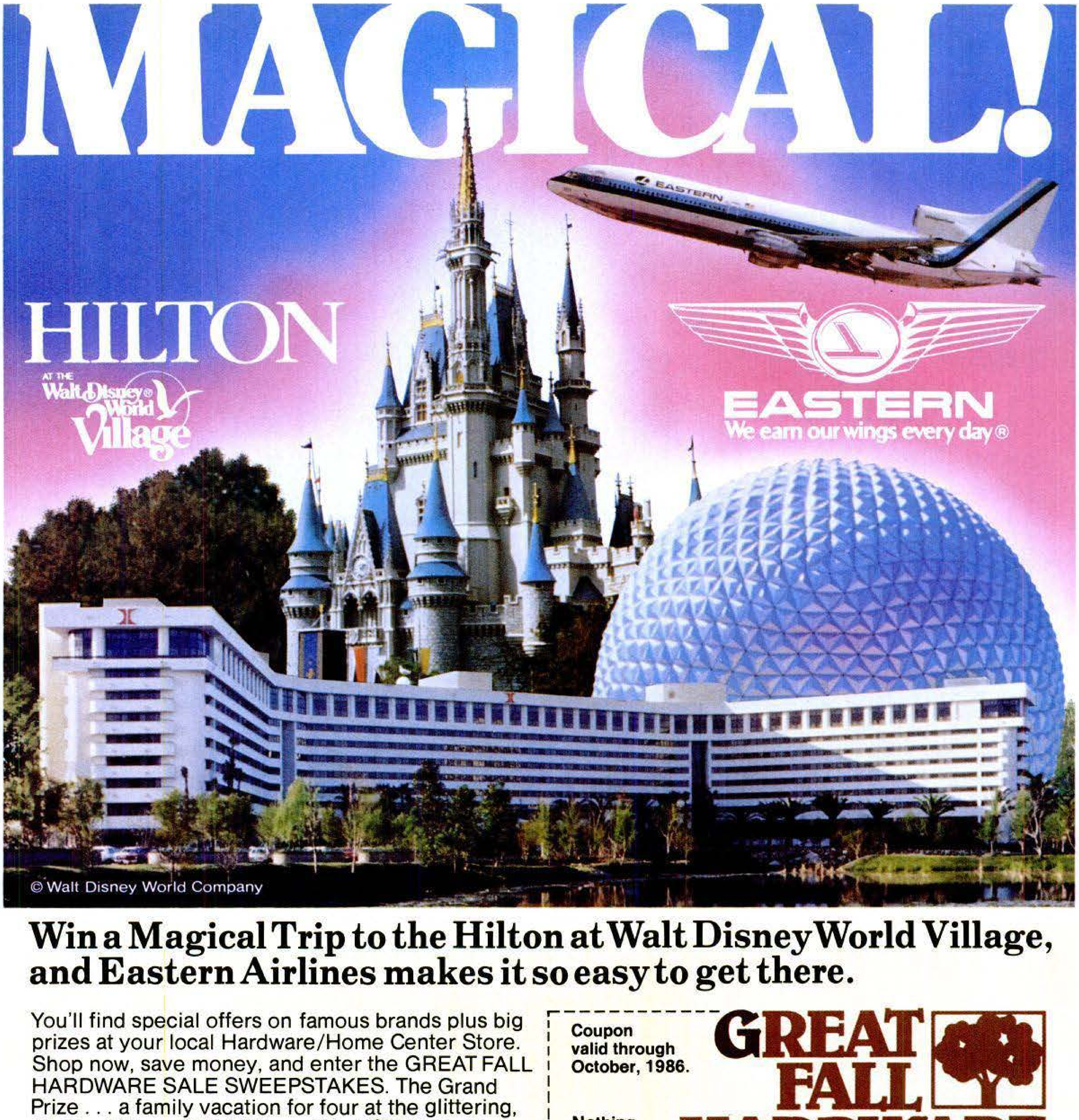
Milky residue

My 1979 American Motors Concord with the 258-cu.-in. six-cylinder engine has a milky buildup in the breather filter and in the oil-filler cap. The PCV system has been checked out, and there is no sign of water on the oil dipstick, which would indicate a faulty head gasket. I cannot get this problem resolved.

Kenneth Nadler, Staten Island, N.Y.

That milky look is caused by water in the oil. You can demonstrate this if you take a cupful of the oil and warm it on the stove to 220 degrees F; the water will disappear. The odds are your PCV valve is either faulty or too small (restrictive). You should also check for a leaky breather hose.

Got a car problem? Send it to "Say, Smokey—," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters not selected for publication.


MAGICAL!
HILTON
AT THE Walt Disney World Village
EASTERN
We earn our wings every day®
© Walt Disney World Company

Win a Magical Trip to the Hilton at Walt Disney World Village, and Eastern Airlines makes it so easy to get there.

You'll find special offers on famous brands plus big prizes at your local Hardware/Home Center Store. Shop now, save money, and enter the GREAT FALL HARDWARE SALE SWEEPSTAKES. The Grand Prize . . . a family vacation for four at the glittering, all-new Hilton at Walt Disney World® Village, an official Disney hotel convenient to all Central Florida attractions and transportation! Your family could fly round-trip on Eastern Airlines to Orlando! Hundreds of other prizes, too! See the complete list of prizes and sweepstakes rules at your participating retailer, deposit your entry and enjoy big savings on top brand names during October.

Shop now for the special values on the following pages.

Note: Some participating stores may not stock all items shown.

NRHA National Retail Hardware Association

Coupon valid through October, 1986.

Nothing to buy or write.

GREAT FALL HARDWARE SALE℠

Enter me in the Great Fall Hardware Sale 1986 Sweepstakes.

Name __________

Address __________

City __________ State __________ Zip __________

Retailer's Name __________

Retailer's address __________

City __________ State __________ Zip __________

Sweepstakes subject to Federal, State and Local laws. Void where prohibited by law. All prizes will be awarded on a national basis.

It's The Great Fall Hardware Sale

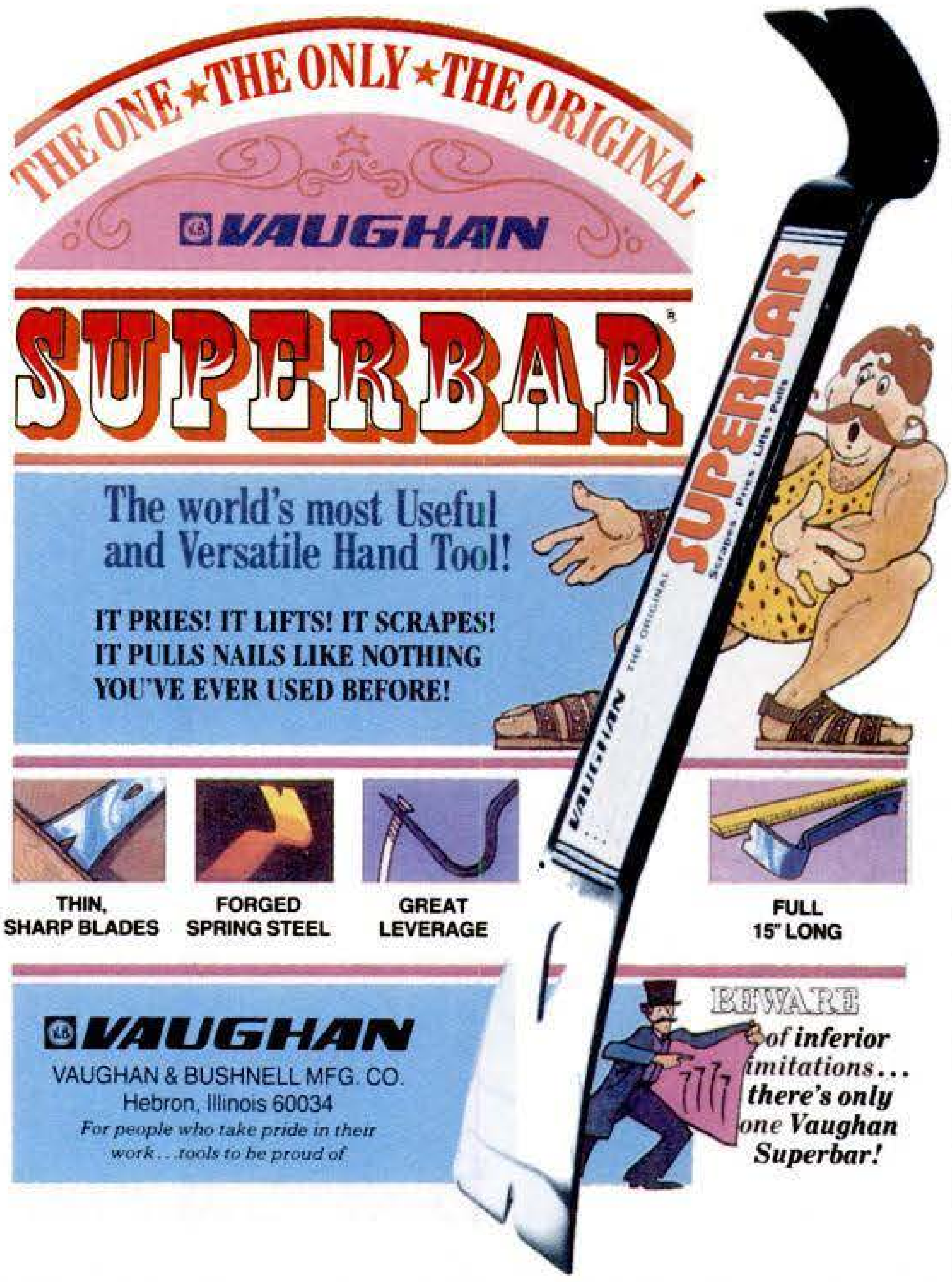
Simple Green

Revolutionary all-purpose cleaner.

Strong enough to degrease an engine, gentle enough to remove stains from fabrics. Cleans engines, tires, R.V.'s, kitchens, appliances, and blood. Non-toxic • Biodegradable • Non-abrasive

Revolutionary all-purpose cleaner.
simple green
Concentrated automotive and household degreaser.
Removes grease, grime and tough stains instantly!

Available at your favorite Hardware or Home Improvement Store.


THE ONE ★ THE ONLY ★ THE ORIGINAL
VAUGHAN
SUPERBAR
THE ORIGINAL
VAUGHAN
SUPERBAR
Scrapes · Pries · Lifts · Pulls

The world's most Useful and Versatile Hand Tool!

IT PRIES! IT LIFTS! IT SCRAPES! IT PULLS NAILS LIKE NOTHING YOU'VE EVER USED BEFORE!

THIN, SHARP BLADES

FORGED SPRING STEEL

GREAT LEVERAGE

FULL 15" LONG

VAUGHAN

VAUGHAN & BUSHNELL MFG. CO.
Hebron, Illinois 60034

For people who take pride in their work . . . tools to be proud of

BEWARE *of inferior imitations . . . there's only one Vaughan Superbar!*

PowerPal
Air Compressor
CAMPBELL HAUSFELD
PowerPal
3/4 HP AIR COMPRESSOR
UL

ALL THE POWER YOU'VE ALWAYS WANTED.

It's all in the ¾ HP, 7½ gallon tank-mounted Power Pal.™ An air compressor that powers over 14 different air tools. It's oilless and maintenance-free. U.L. listed, too. No wonder the tank-mounted Power Pal is the #1 selling air compressor in the United States.

IT'LL PAINT AND PRIME.

IT'LL AIR OUT A FILTER.

IT'LL UNBOLT A SHOCK.

IT'LL INFLATE AND ROTATE.

IT'LL KNOCK OFF A MUFFLER.

THE CAMPBELL HAUSFELD TANK MOUNTED COMPRESSOR

For your local dealer call 800-543-8291. In Ohio, 513-367-3125

150th Anniversary
CAMPBELL HAUSFELD
1836-1986

Save Now on These Famous Brands

TOP BRANDS! GREAT VALUE!

Turner®
Two Piece Propane Torch Kit LP5555
Seven Piece Propane Torch Kit LP999

Nicholson®
#150 26" Handsaw
Superior® Chainsaw Files
6" x 5/32" 8" x 3/16" 8" x 7/32"

Plumb®
16oz Fiberglass Curved Claw Hammer 11-402
16oz Hickory Handle Curved Claw Hammer 11-436
16oz Ultralite Curved Claw Hammer 11-470

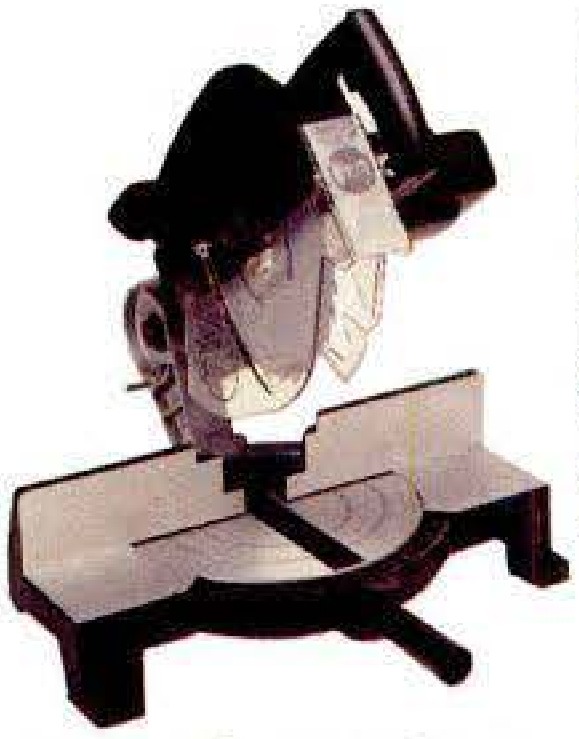
Turner
PROPANE FUEL
NICHOLSON
Special Steel
Plumb
PERMABOND

CooperTools

COOPER INDUSTRIES

CRESCENT® LUFKIN® NICHOLSON® PLUMB® TURNER® WELLER® WIRE-WRAP® WISS® XCELITE®

SUPER SAVINGS ON BLACK & DECKER POWER TOOLS



9" POWER MITER SAW

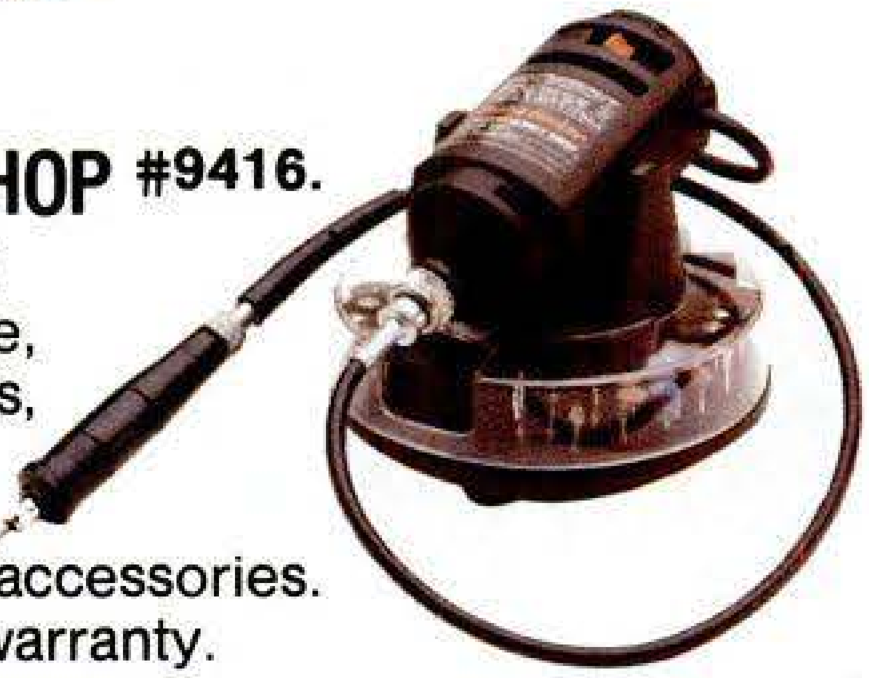
WITH A $10 REBATE
Powerful 2*HP ball & sleeve bearing motor handles difficult jobs. 5 positive stops. Full 2-year home use warranty. #7715
*Max. motor output

16" HEDGE TRIMMER #8124.

WITH A $5 REBATE
Shrub and hedge trimming made easy with lightweight double-edge trimmer. Wrap-around handle for control. Full one-year warranty.

M47 SERIES™ 3/8" VSR DRILL #7144.

WITH A $5 REBATE
For the tough jobs. More power, higher torque. Compact, easier to handle. Full 2-year home use warranty.



ROTARY HOBBY SHOP #9416.

WITH A $7 REBATE
Sand, grind, etch, carve, polish & sharpen metals, ceramics and wood. Revolving carousel with storage. Includes accessories. Full 2-year home use warranty.

8" RANDOM ORBIT POLISHER #9530.

WITH A $10 REBATE
Takes the hard work out of polishing trucks, cars or boats. Simulates hand polishing. Full 2-year home use warranty.

BLACK & DECKER™

Take advantage of these super savings today and enter to "Win a Black & Decker Workshop" at participating outlets. Details at store display.

WIN A BLACK & DECKER WORKSHOP FREE

Rebates good August 24, 1986 through January 3, 1987.

ARROW®

FASTENING TOOLS
DO IT ALL!

The
ONE source for all your home fix-it fastening needs

Model **T-50**
Professional All Purpose Heavy Duty
STAPLE GUN TACKER
All steel construction.
High carbon hardened steel working parts.
Shoots a staple wherever you'd drive a nail.
Uses 6 No. T-50 staple sizes: 1/4", 5/16", 3/8", 1/2", 9/16", and Ceiltile.

Model **TR-550**
Professional

ARROW® ELECTRO-MATIC

NEW

HOT MELT GLUE GUN
Automatic Lever Feed

- Lever-Feed Clutch Mechanism
- Built-In Drip Tray/Stand
- Interchangeable Nozzle
- Re-Usable Storage Box
- Cool Contoured Handle
- Uses 2" or 4" Glue Stix
- Light Weight

Model **TH-500 Thumb Feed**

ARROW® XPANDO™

Model **T-50XP XPANDO**
Staple Gun Attachment

NEW

Shoots XPANDO fasteners that grip firmly in wood, masonry, metal, hollow doors, and sheetrock

THE WORLD-FAMOUS T-50 STAPLE GUN
Instantly Converts to a
MULTI-PURPOSE FASTENING TOOL!
For exclusive use with Arrow T-50, T-50M, & T-55 Staple Guns.

Arrow Fastener Co., Inc., Saddle Brook, N.J. 07662
©Copyright 1986 Arrow Fastener Company Inc.

Elmer's Build-A-Memory Series.

BORDEN®

IF YOU WANT TO BUILD LASTING MEMORIES, ELMER'S WILL SEND YOU THE PLANS.

Build a saltbox doll house. A child's table. Or winged-back chair.

Elmer's® has some special plans for that someone special. With easy-to-follow instructions for a child's doll house, table, and chair in authentic colonial designs. And because they're made with Elmer's® Carpenter's Wood Glue, you know you'll get professional results every time. Just send the UPC code number from either Elmer's Carpenter's Wood Glue or Elmer's Carpenter's Wood Filler, and we'll send you the plans for $3.00 each. So for years of lasting memories, go with the lasting name in glue. Elmer's.

(20"x19"x32") (31"x14"x14")

Please specify plans (doll house, table, chair) and send check or money order and UPC code number to: Elmer's Plans Offer, P.O. Box 2383, Van Nuys, CA 91409-2383.

© Borden Inc 1986

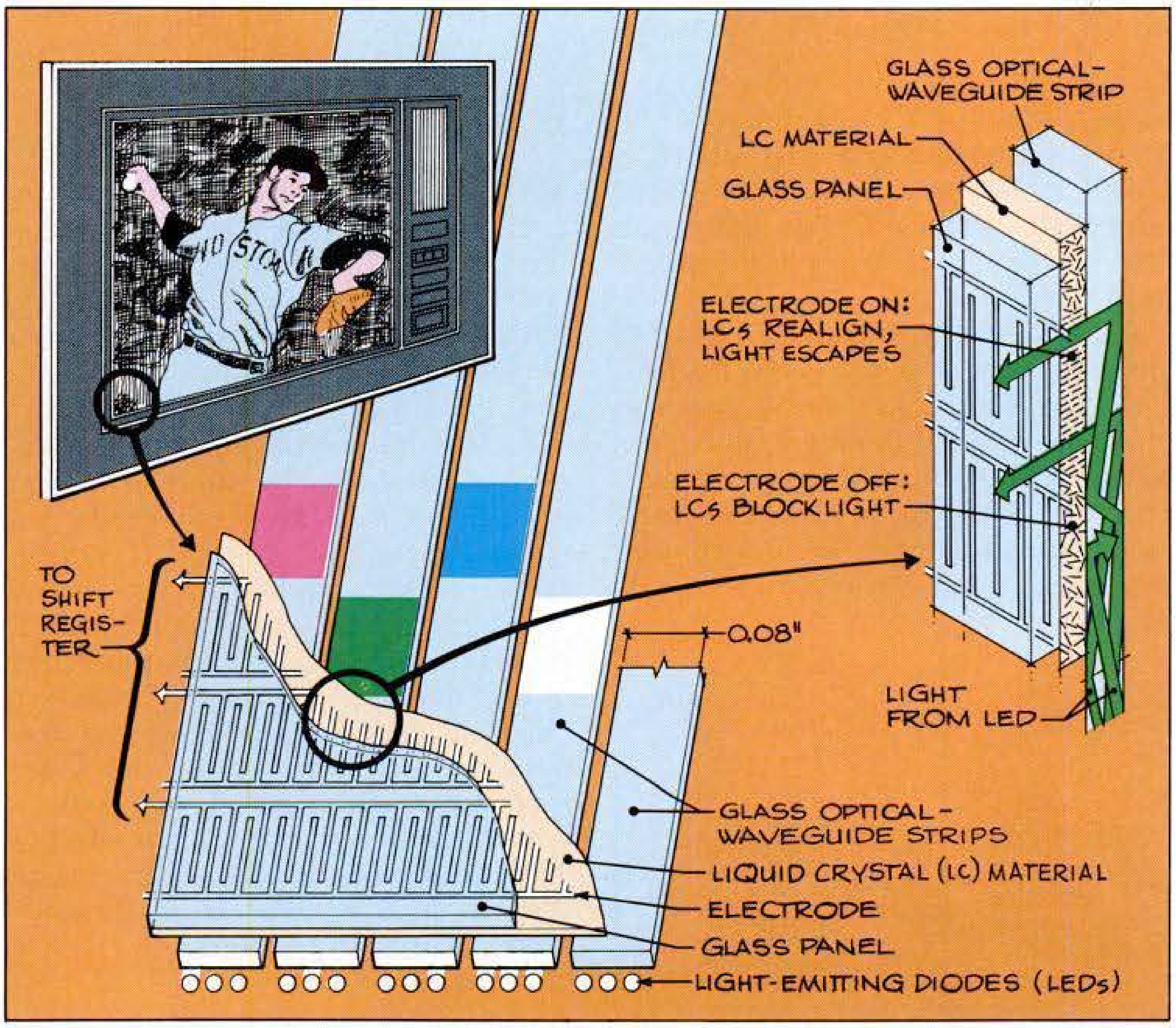
Optical strips beam images for flat TV

A new method of creating images has a parallel grid of thin glass strips that trap red, green, and blue light produced by video signals, guiding it invisibly up a panel. At the right moment, electrodes switch on liquid crystals contacting the strips. Light escapes to form TV or computer pictures.

By DAVID SCOTT
Drawing by Eugene Thompson

Professor Mino Green points to a blackboard on his office wall at the Imperial College of Science and Technology in London. "Our flat TV screen could look like that," he says. "It's a large-area liquid-crystal display [LCD], different from any other. Unlike existing LC screens on portable computers, ours is color, gives a bright, contrasty image, and allows wide-angle viewing. Our display combines optical waveguides with electronic switching in a unique concept."

This concept, however, is still in early development at the college where Green teaches. But it promises a significant improvement for TV, computer, and other display screens of unlimited size. A British data-communications firm is backing the project to speed it onto the market.


GLASS OPTICAL-WAVEGUIDE STRIP
LC MATERIAL
GLASS PANEL
ELECTRODE ON: LCs REALIGN, LIGHT ESCAPES
ELECTRODE OFF: LCs BLOCK LIGHT
TO SHIFT REGISTER
0.08"
LIGHT FROM LED
GLASS OPTICAL-WAVEGUIDE STRIPS
LIQUID CRYSTAL (LC) MATERIAL
ELECTRODE
GLASS PANEL
LIGHT-EMITTING DIODES (LEDs)

Flat TV panel in artist's concept has glass optical-waveguide strips as vertical columns covered by a glass panel with rows of nearly invisible electrodes. LC material is sandwiched between the strips and glass sheet. Three colored light-emitting diodes (LEDs) at the bottom edge of each strip are fired in a horizontal sequence by a red, green, and blue video signal. Simultaneously, a shift-register circuit applies AC pulses to the horizontal electrodes one row at a time. The electric field at each electrode-strip crossover realigns the LCs, allowing light to escape (detail). LED selection here creates pure red, green, and blue picture elements, plus white (three LEDs fired at once).

"The basic idea," Green says, "is that a light beam bounced internally along a thin strip of glass can be released at any point along its length as a spot of light by a 'windowing' system."

In his lab, Green shows me a small experimental display for this controlled release of light. It's achieved, he explains, by sandwiching LC material between a sheet of glass and columns of narrow glass strips. In LCDs, molecules flip back and forth under the influence of voltages to either block or pass light and form an image. In Green's experimental panel, LC material pressed against the strips normally has its molecules oriented so their low refractive index (ability to bend light) doesn't influence how each glass strip conducts light.

But increasing the refractive index at a specific point on a strip makes it leak light instead of trap it. To change the index, voltage pulses are applied to rows of electrodes on the glass panel. The electric field from these pulses shifts the orientation and refractive index of the LC molecules. And because the LC material touches the optical strips, light can spill out to become a tiny picture element.

Panel design would be altered to fit the application. A TV screen, for example, would have a number of horizontal electrode rows equal to the display lines for the local TV standard (625 in Britain and 525 in the U.S.).

LC switching

Also for TV, each vertical glass strip might be 0.08 inch wide, with hundreds of them creating a hang-on-the-wall panel more than four feet wide. Each strip would have a red, green, and blue light-emitting diode at its bottom edge. A video signal split into red, green, and blue components would activate the diodes for each glass column. And circuits switching the electrode voltages, precisely synchronized with the video signal, would allow light to escape and paint TV pictures.

That's the theory. And the principle works on the small rig in Green's lab. "There's still a lot to be done," he says, "particularly in working out the optimum time constant for LC switching, and reducing their recovery times to avoid unwanted light persistence after switch-off. These are the critical factors." With these problems licked, the rest should be easy, he figures, and a big, flat TV screen could be ready in a few years.

Electronics Newsfront

By WILLIAM J. HAWKINS

Tandon
Tandon

Price busters: Tandon's PC-compatible (left) and AT-compatible computers.

Big blues for Big Blue?

Don't sell your shares of IBM stock, but the company is finding its strongest competition since it first introduced the PC. The computers are called compatibles. They work like a PC, often look like one, and—most importantly—use IBM PC software. What makes them different? Price.

"Our prices are 32 to 46 percent lower than comparable IBM units," says H. L. Sparks, vice president of Tandon Corp., the most recent company to enter the fray. Where true-Blue PC prices hover at a $1,995 starting point, Tandon's begins at $1,155 for a single-drive, 360 kilobyte (K), 256K-memory machine. Tandon (20320 Prairie St., Chatsworht, Calif. 91311) was originally a disk-drive maker—a fact on which company president, Sirjang Lal Tandon, intends to capitalize: "A disk drive can account for as much as forty percent of a computer's cost," he told me.

Tandon has two other PC-compatible models: a $1,295 PCX-2 with dual disk drives, and a $1,795 PCX-20 with a single floppy drive and a 20-megabyte hard disk. All models accept up to 640K of memory. The IBM AT has been cloned, also. Tandon's $2,195 basic model has a 512K memory and a single 1.2-megabyte disk drive. A $2,695 model includes a 20-megabyte hard disk. And for $3,595 there is a model with a high-speed 40-megabyte hard disk.

All models come with the MS-DOS operating system and GW BASIC. Hidden costs? "You'll need to add a video display and video connector board to the computer," says Tandon. "But, at $280 for a fourteen-inch monochrome display and board, you can get a complete system for just $1,435."

While Tandon may be the newest entry into the PC market, the company is hardly alone in price cutting, and it has competitors other than IBM. Lately, you need a scorecard to keep up with changes from companies like Leading Edge, Epson, Kaypro, and Tandy. "This is the year of the compatibles," says John Roach, chairman of Tandy. Translation: We're in the middle of a price war.

(Last-minute update: Tandy has just introduced five new PC-compatible computers, starting at $799 for a home version. A basic business version—384K of memory and two 360K floppy-disk drives—is $1,199.)

ALV update

The vehicle traveled at 6 mph, successfully maneuvered around a sharp curve along the winding 2.5-mile test track—and set a new speed-distance record. The catch: Nobody was driving. This was the latest test of the Autonomous Land Vehicle—ALV—first reported in Popular Scienc in October '85. Designed by Martin Marietta for DARPA (Defense Advanced Research Projects Agency), the ALV uses a video camera and laser scanning system for eyes, and a computer programmed with artificial intelligence as a brain.

ALV
ALV
WARNING

An over-the-road ALV passes the latest pilotless speed-distance test.

For the record

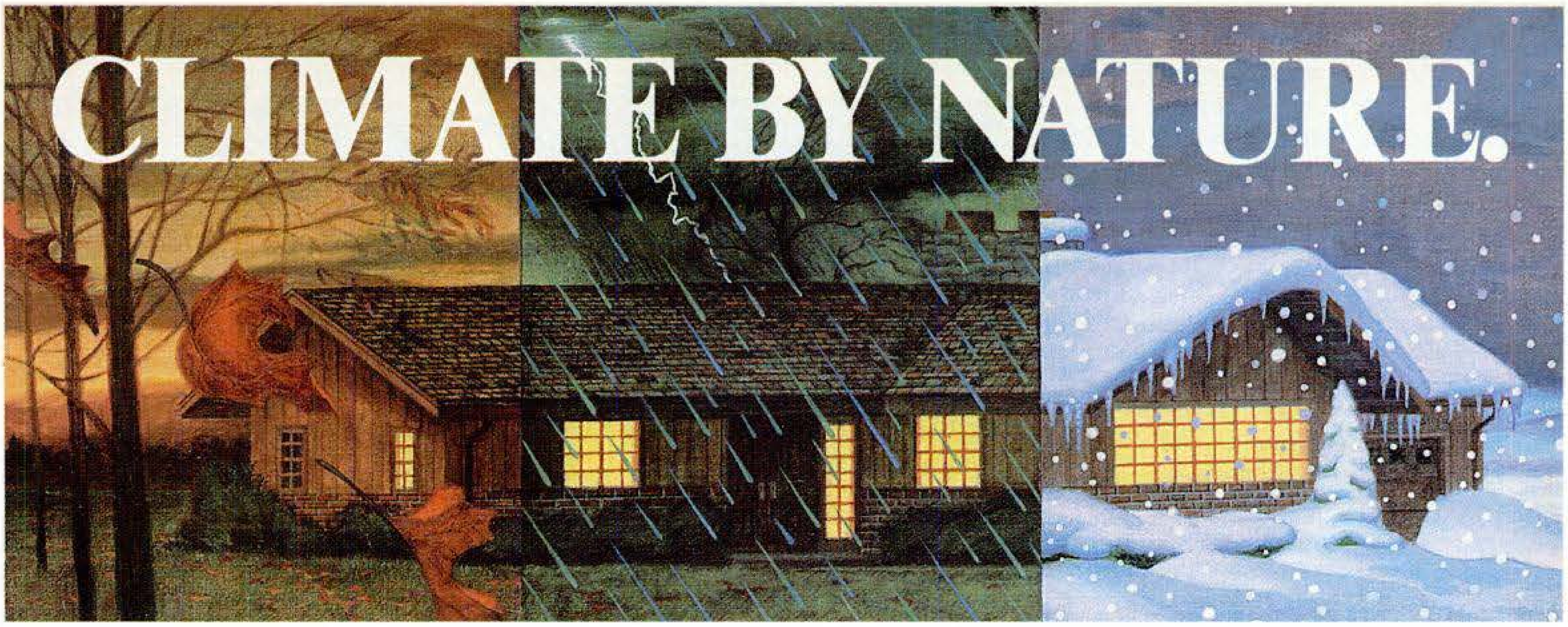
When police officers use a tape recorder to interview suspects, the recording may not be admissible in court. The tape could be tampered with, claim defense lawyers. But a new 3M TPR (tamper-protected recording) system could change all that.

A TPR hand-held microcasette recorder contains two microprocessors and, using two recording heads, records two tracks on tape. The first track contains the audio; the second holds digital data: an identification number, verification information (time of day, date, security code), and voice characteristics (amplitude and frequency). If the tape is erased, rerecorded, edited, or spliced, it will be detected when played through the TPR player-verifier (see photo), and the results displayed on a five-inch screen or paper printout.

Quick looks

- When a laser beam is injected into a Matsushita-developed lithium niobate chip, the light's wavelength is halved. That allows it to be focused on a spot that's one-quarter the diameter of the original beam. Using the

Continued


CLIMATE BY NATURE.

COMFORT BY CARRIER.

With a high-efficiency Weathermaker® gas furnace.

Compact. Durable. With the kind of whisper-quiet quality you'd expect from a name like Carrier. This is the Weathermaker—the most efficient line of gas furnaces Carrier has ever made. With fifty-eight years of engineering know-how plus the foresight to use dependable gas, Carrier has created a furnace with unsurpassed economy and comfort. Comfort in the sense of warmth. Economy in the sense of significantly reduced heating costs. To learn more about the wide variety of models available, call your Carrier dealer. Today.

weathermaker SX
Carrier

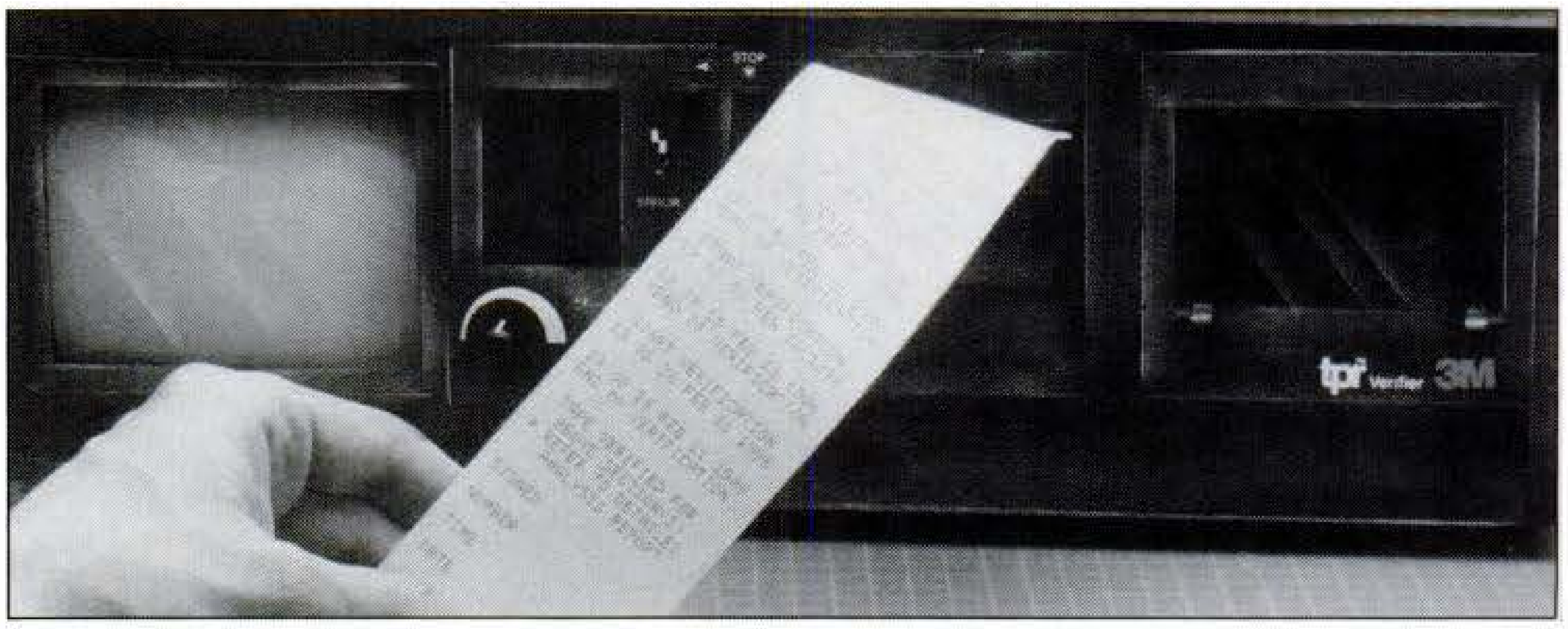
Carrier®

When you compare the costs of all energies, gas now gives you even more for your money.

Gas. America's best energy value.

©1986 American Gas Association

new device, future compact discs (CDs) and videodiscs could gain a fourfold increase in programming material.



A player-verifier tests a tape that was recorded on 3M's new TPR system.

- At Ludwigshafen, West Germany, BASF chairman Hans Albers reached under a table, pulled out a small tape recorder, and played back his opening remarks to an audience assembled to learn about a new product development. The point? The recorder was powered by a pyrrole polymer dry cell—a plastic battery. It can be molded into any shape, recharged up to 500 times, and, when depleted, can be burned for disposal.
- An obscene phone call? Don't hang up without first pressing a button on Sony's counterattack phone. It records 16 seconds of the caller's voice, then plays it back 10 times before hanging up. The phone, not yet available here, is $122 in Japan.
- High-capacity data savers: Rioch's five-inch write-once optical disc for personal computers holds 800 megabytes of data. Core International (7171 N. Federal Hwy., Boca Raton, Fla. 33431) has shown an AT-compatible computer with a 1,000-megabyte internal hard-disk storage system.
- The slow, methodical snipping of the barber's scissors moving around and above my head nearly put me to sleep. It was so realistic I had to remind myself that I was wearing earphones and listening to a tape made by Holophonics (Box 64770-294, Los Angeles, Calif. 90064). Its creator, Hugo Zuccarelli, claims that the three-dimensional realism comes from his new recording process that mixes sounds with an inaudible frequency that the human ear emits to use as a reference for direction. Sometimes the sound becomes audible, he believes, when people hear ringing in the ears.
- Where did the computer age get its start? The Dept. of Commerce says it was the Census Bureau when they switched on the UNIVAC I 35 years ago.
- Two high-tech warnings: "If you're spending a lot of time communicating with a computer," says California State University psychology professor Larry Rosen, "your skills at communicating with people become tarnished. Computers can damage family communication." Auto stereo systems can damage more than your communication skills, according to the Insurance Information Institute. To prevent accidents, turn the volume down, particularly when the traffic gets hectic. PS

Stop Nox. It Really Does Stop Knocks!

STOP NOX does just what it says—it stops those damaging knocks and pings in most cars and light trucks.

Just add one easy-pour bottle of STOP NOX into your tank. Then fill up with gas.

You'll hear and feel the difference. Your engine will run cooler. Cleaner. Smoother than ever before.

STOP NOX works with any gas, leaded or unleaded. And it's completely safe for your engine.

Don't settle for cheap, worthless imitations. Insist on STOP NOX. From 104+, the world's No. 1 brand of quality fuel additives. 104 OCTANE BOOST ™

ORDER DIRECT:
104+ RACING CAP
Red and white with four-color embroidered insignia. One size fits all—$5.

OCTANE BOOST CORPORATION
Box 271148
Dallas, Texas 75227

STOPS KNOCKS AND PINGS! INCREASES MPG!
NEW EASY-POUR BOTTLE!
104 OCTANE BOOST
STOP NOX ™
NET 8 OZS. 236 LITERS
DANGER:
HARMFUL OR FATAL IF SWALLOWED.
Contains petroleum distillates.
Read other cautions on back carefully.

MICRO EYE
EXPRESS·LR
FILTER
LO LR
RSD
LO LR
POWER
OFF ON
BEL

THE LATEST WORD IN RADAR DETECTION IS THE MICRO EYE EXPRESS-LR

Latest, because the MICRO EYE EXPRESS LONG RANGE is a dual superheterodyne radar detector like no other. It represents the first superheterodyne radar detector to integrate computer based signal processing with superheterodyne circuitry for extra long range superheterodyne sensitivity and increased selectivity. Leave it to BEL — the largest manufacturer of radar detectors to once again pioneer superior technology in a radar detector.

TECHNOLOGY BRINGS OUT THE BEST

You don't need to understand the technology behind the EXPRESS-LR to know what it delivers — confidence on the road. Over hills, around corners, or on the straightaway, the EXPRESS-LR detects both X and K Band radar with a systematic audio and visual alert warning you to the presence of police radar. Whether pulsed, moving, or triggered, the EXPRESS-LR reacts reminding you to slow down.

SENSITIVITY TIMES TWO

The MICRO EYE EXPRESS contains both Radar Signal Discrimination and a LO/LR Filter Switch. RSD (exclusive to the B.E.L-Tronics line of radar detectors) reduces X Band to an optimal level for urban/suburban driving. This mode instantly analyzes all incoming signals and processes only those that are true signals (police radar). The Filter Switch has been designed to virtually eliminate annoying false alarms caused by microwave relay stations, automatic door openers, and weather radar. The use of both the RSD and Filter Switch together will give you the ultimate in selectivity, without reducing the sensitivity of the MICRO EYE EXPRESS-LR.

HIGH PERFORMANCE

The MICRO EYE EXPRESS-LR is the most technically advanced radar warning system you can buy. The unit comes complete with all the accessories needed for quick and easy installation, a full one year warranty, and the integrity of a company with 19 years of microwave electronics expertise. The MICRO EYE EXPRESS-LR is truly your final touch to full driving confidence.

30 DAY TRIAL OFFER

You can order yours today by calling this toll-free number, and if not completely satisfied with your MICRO EYE EXPRESS-LR, simply return the unit within 30 days for a full refund (mail order only).

MICRO EYE EXPRESS-LR
$299.95

Call toll-free 1-800-341-1401
In New York 1-800-845-4525
In Canada 1-800-268-3994

(NY residents add applicable tax. Price higher in Canada) Please allow an additional 15 days when paying by personal or company check.

VISA MasterCard AMERICAN EXPRESS

FULL ONE YEAR
WARRANTY ON
PARTS AND LABOR.

B.E.L-TRONICS Limited
International Head Office
2422 Dunwin Drive,
Mississauga, Ont., Canada
L5L 1J9

In U.S.
20 Centre Drive
Orchard Park, NY 14127

Model 844s

BEL B.E.L-TRONICS LIMITED The Radar Detector Innovators

900 PS

Sports coupes
nimble, quick . . . and affordable

POPULAR SCIENCE CAR TEST #211
Total cars tested to date: 760

Responsive four-valve engines and agile handling put Acura Integra, Toyota Celica GT-S, and Volkswagen Scirocco 16V out in front.

By TOM WILKINSON
and JACK KEEBLER
Photos by Greg Sharko

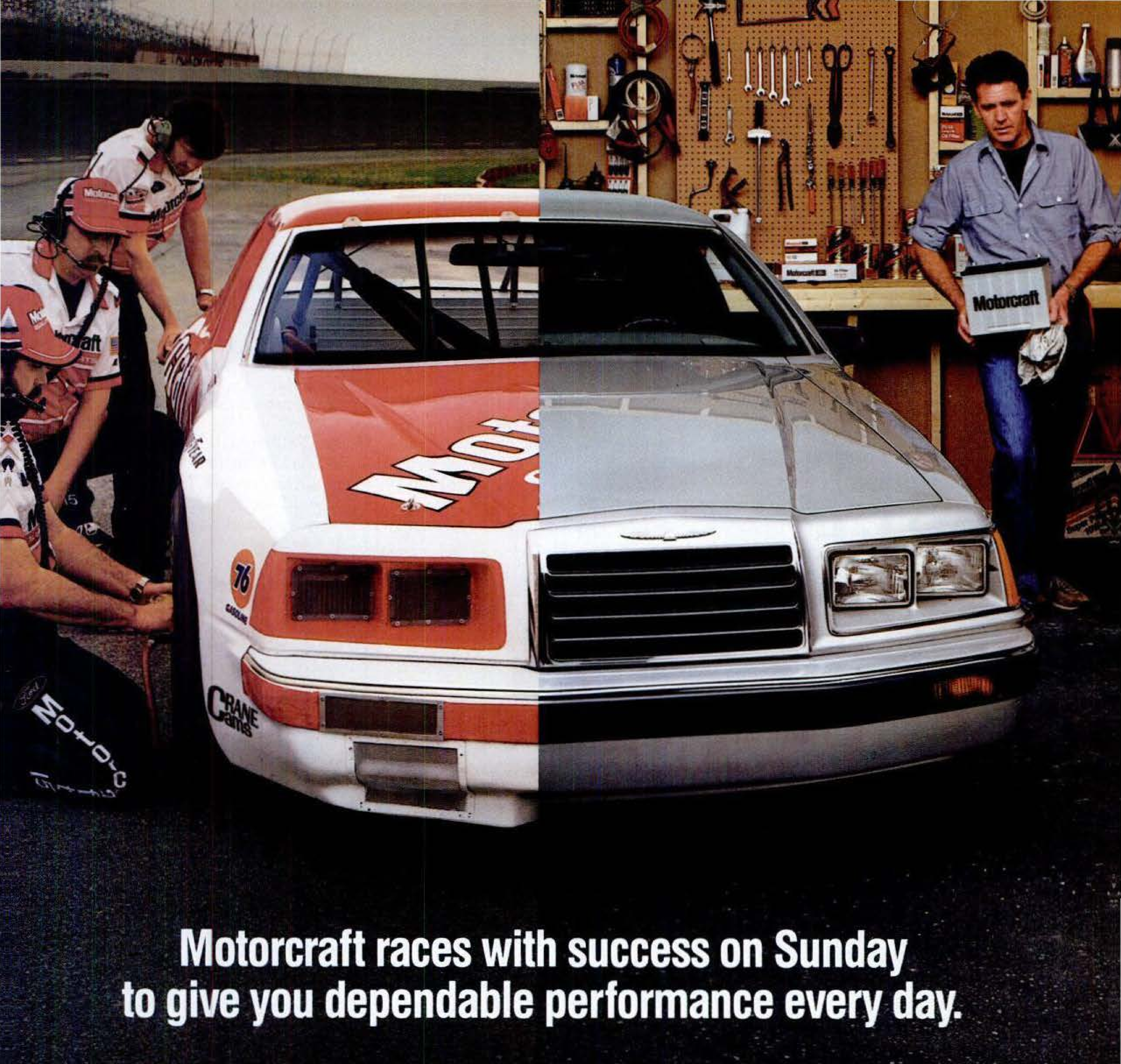
Here's the answer for all the Walter Mittys of the highway, for all those who dream they're diving under Danny Sullivan while taking that tight left into the shopping center. Here's something for those who look at a freeway on-ramp and see turn one at the Indianapolis Motor Speedway, and who imagine every icy suburban street to be a treacherous stretch of the Rallye Monte Carlo.

Here are three sports coupes that put joy into everyday driving. Small and light, with sticky tires and free-revving four-valve engines, they outperform many cars far more powerful. Their responsive controls encourage smooth, skillful driving, not tire-squealing starts and law-breaking top speeds. And their moderate price tags, excellent fuel economy, and good use of interior space make them practical for many young families.

The Integra LS, Celica GT-S, and Scirocco 16V proved to be three of the most closely matched cars Popular Science has ever tested. There are some subtle but significant differences,

Continued

Three four-valve coupes (top, from left to right): VW Scirocco 16V, Acura Integra LS, and Toyota Celica GT-S. Though the Scirocco is German and the other two Japanese, the three were closely matched. All were fast and predictable during handling tests. And their powerful engines and nimble chassis made any one of them just about perfect for a winding road.



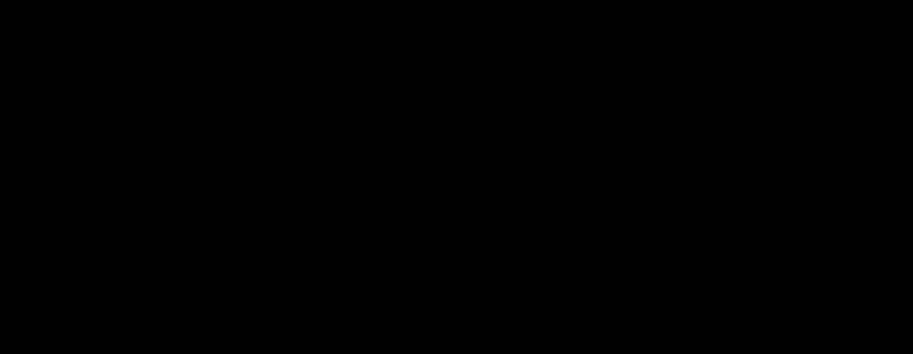
Motorcraft races with success on Sunday to give you dependable performance every day.

Motorcraft quality parts are tested on some of the world's toughest racetracks on Sunday, so you're not tested during the rest of the week.

High-performance racing cars that generate about 600 horsepower demand tough, quality parts. So does your car. And Motorcraft spark plugs, filters, batteries and motor oil help deliver top performance on the racetrack on Sundays and on the highway every day of the week.

Motorcraft quality parts have been installed as original equipment in more than 35 million Ford, Mercury, Merkur and Lincoln cars and Ford light trucks. But no matter what kind of car or truck you drive, there's only one logical choice. Quality Motorcraft parts from Ford—so you'll know you're getting reliable original-equipment quality replacement parts. Race-proven parts. Trustworthy parts. Motorcraft, of course. Quality parts for all makes of cars and trucks.

Motorcraft from Ford



EXCEEDS THE NEED

Buckle up—together we can save lives.

Copyrighted material

CRUTCHFIELD
CAR STEREO, AUDIO/VIDEO, TELEPHONE CATALOG
Summer 1986
Latest 1986 Models-Low Discount Prices
our 13th year

You'll find the most helpful shopping information in the 108 page Crutchfield catalog.

FREE
Stereo & Video
Catalog

Refer to the latest Crutchfield Catalog before buying your next car stereo, home stereo, or video product:

- 108 pages filled with helpful articles, consumer tips, charts, and installation guides.
- Color photos, complete product descriptions and technical specifications on hundreds of the finest brand name products.

You get more value shopping Crutchfield:

- Toll-free product advice, ordering, and customer service.
- 24 hour shipping.
- Absolute satisfaction guaranteed.
- Full 30-day return privileges.
- Discount prices on Sony, Pioneer, JVC, Teac, Akai, Advent, Jensen, Clarion, Concord, Sherwood, Canon, Infinity, and many more!

Call or send now for your FREE Catalog

Use this coupon or call toll-free:

800-336-5566

In Virginia, call **800-552-3961**

Be sure to mention *Popular Science* when calling.

Name

Address Apt. #

City State Zip

CRUTCHFIELD

1 Crutchfield Park, Dept. PS, Charlottesville, VA 22906.

though. To explore these, we put each through the instrumented test procedure, then turned them over to the Walter Mittys on the PS test staff.

Ordinary origins

To keep prices down, sports cars are usually derived from family sedans. The Acura Integra LS, the newest car in this group, is no exception. Though similar to the Prelude in size, shape, and performance, the Integra is actually related to the current Civic. It uses the same strut-type front suspension as the Civic, and the same three-link beam axle in the rear.

If the chassis sounds a touch pedestrian, the engine isn't. Both the 1.6-liter engine block and cylinder head are aluminum alloy. A pair of belt-driven cams operates two intake and two exhaust valves per cylinder. Fitted with electronic fuel injection, the engine generates a smooth 113 horsepower.

Like the Integra, the Celica GT-S is also a cousin of an existing sedan, the staid but competent Camry. Suspension is independent front and rear, with coil springs and struts at each corner.

The two-liter four-valve four in the Celica was the largest of any in our trio, and produced the most horsepower —135. Like the Integra's engine, it uses two overhead cams driven by a toothed rubber belt. It also is equipped with Toyota's variable induction system, which opens four additional runners in the intake manifold for increased airflow at high engine speeds.

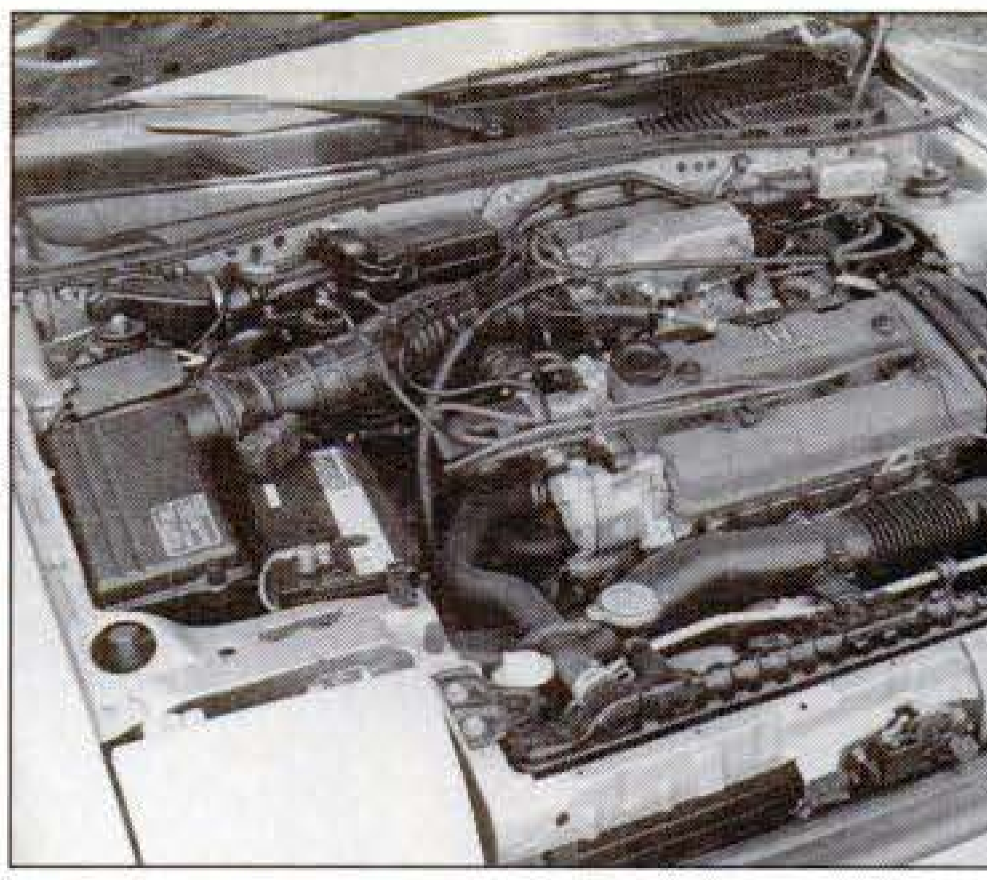


PHOTO BY TOM WILKINSON

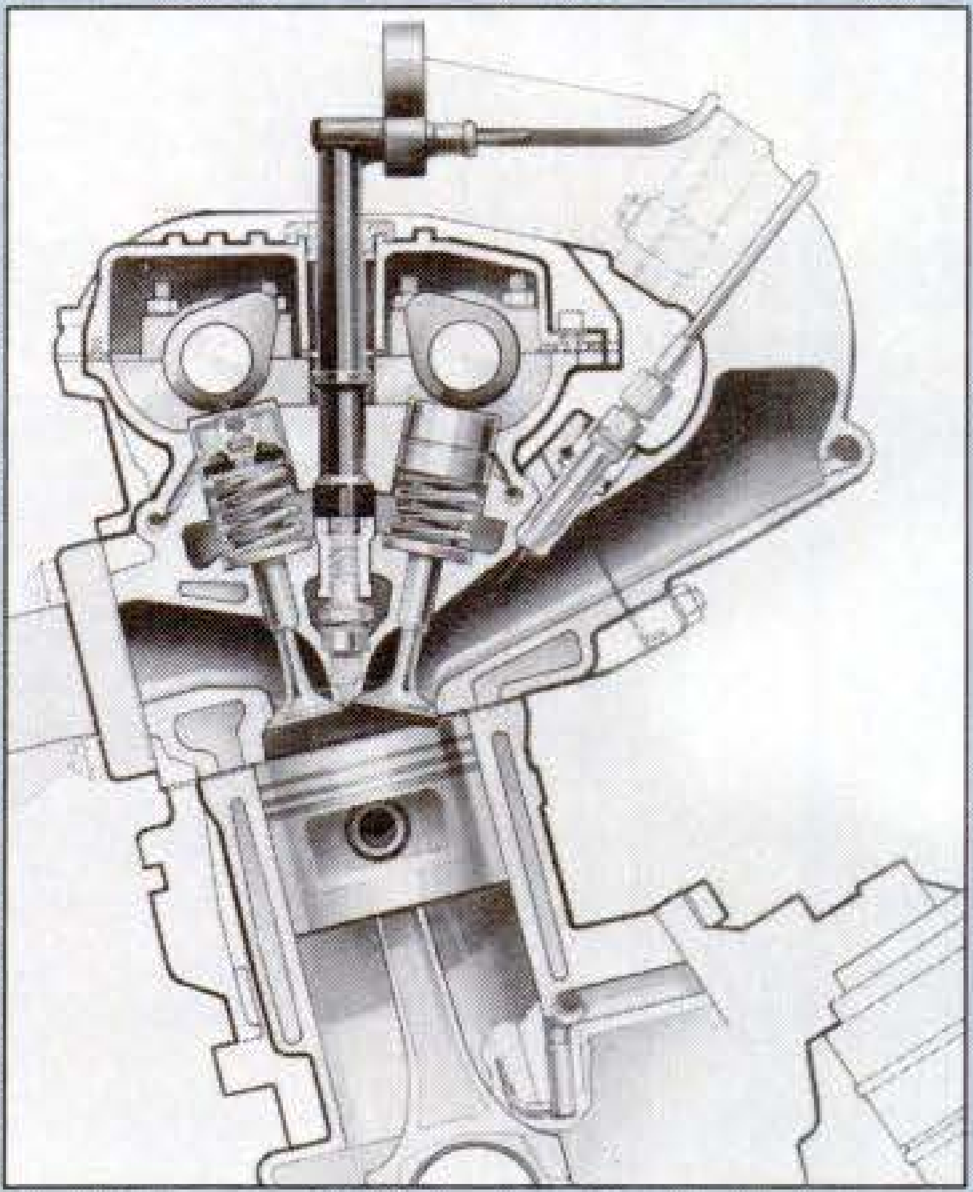
Though it's sold as an Acura, the words "Honda Motor Co." cast into the Integra's cam cover reveal its parentage.

Finally, there's the Scirocco 16V. It's chassis is similar to the Golf sedan's, but it's the first Volkswagen to use the company's newly developed four-valve engine. To accommodate the 123-horsepower four, the suspension has been upgraded. Like the other cars in this trio, brakes are discs all around.

A few engineering twists can be found under the VW's cam covers. Unlike the Acura and Toyota, which use a single belt to turn both cams, the

Continued

Does two plus four always equal 16?



Twin cams, four valves, 16 valves . . . it's getting so you can't tell the engines without a program. All three cars in this group have two overhead camshafts and four valves per cylinder. But Acura refers to a "double overhead cam 16-valve" design; Toyota calls its version a "twin cam"; and Volkswagen refers to the Scirocco engine as "16 valve." Why all these cams and valves in the first place? And why the different names?

The answer to the first question is simple: More valves equal more horsepower. Four valves per cylinder allow more air-fuel mixture to be drawn into the cylinders, and allow designers to put the spark plug in the center of the chamber for more efficient combustion. Also, because the valves and lifters are lighter, the engine can turn faster. All of this means more power from a four-valve engine.

The classic four-valve head uses a chamber shaped like a shallow triangle, with the intake valves on one side and exhausts on the other. In search of a narrower cylinder head, VW did things differently (left), putting the intake valves at a steep angle and the exhausts almost straight above the piston.

But what about the variety of names? The current popularity of the four-valve cylinder head owes much to a series of Ford-based Cosworth engines built during the 1960s. These often were called "Twin Cams," and the name stuck. For the most part, the terms "twin-cam," "four-valve," and "double overhead cam" mean the same thing.

Not always, though. A six-cylinder four-valve engine would properly be a "24-valve." Then there's the Acura Legend, which uses four valves per cylinder but drives all four from a single camshaft. Meanwhile, motorcycle builders often use double overhead cams to drive a single intake and exhaust valve per chamber. Program, anyone?—T. W.

SR-71 BLACKBIRD NO. 2

BLACKBIRD™

AEROSPACE SHIRTS

CAPTURE THE EXCITEMENT! All the leading Aerospace Manufacturers wear them, now you can too! Unbelievably detailed electrifying High Technology visual illustrations of the worlds most exotic and advanced aircraft, screen printed in brilliant colors on the Front and Back of **Navy Blue** or **Black** Hanes 100% Cotton Beefy-T's. All shirts are **$15** each. Sizes S(34-36), M(38-40), L(42-44), XL(46-48). Allow 2 to 3 weeks for delivery. Specify aircraft, size, and color when ordering. Also Available B-52, C-5B, NASA, T-38. **100% Guaranteed**

Shipping: Add the following

	First Shirt	Ea. Addt'l
USA	$2.25	$ .50
Canada	$3.50	$ 1.00
Others	$6.50	$2.50

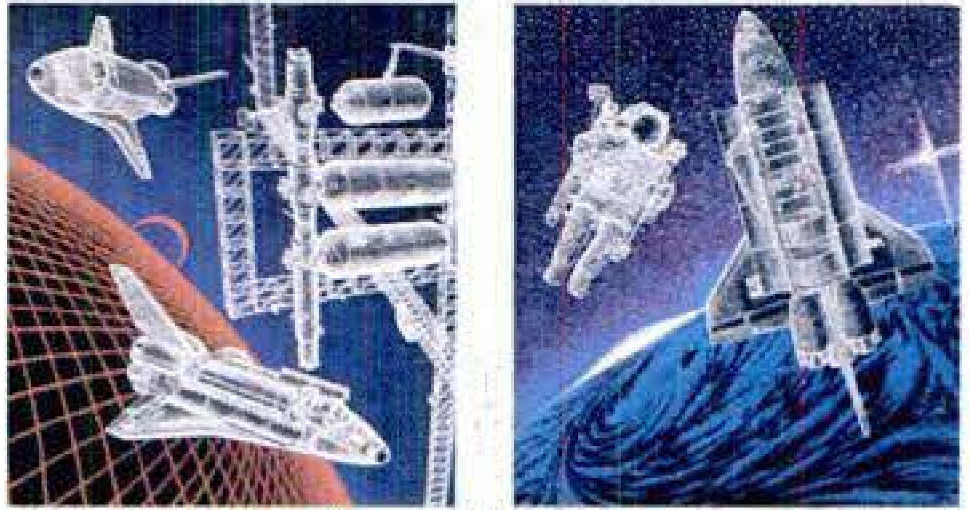
Large Orders: 24 shirts/$12.50 ea.

CREDIT CARD ORDERS TOLL FREE
800 272-7171 **NO COD's**

Or send a check including shipping charge and specify aircraft, size, and color. AZ customers add 6.5% sales tax.

Customer Service (602) 966-7613

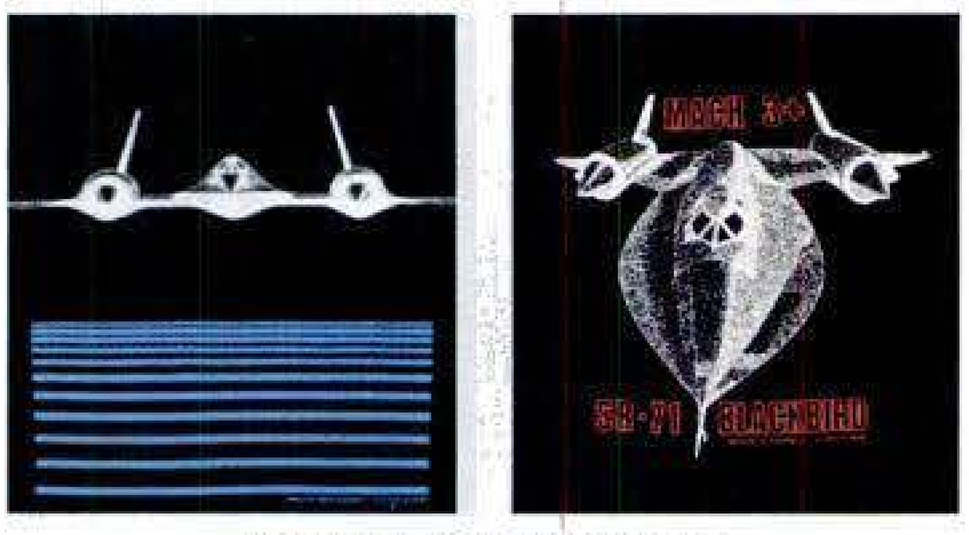
BLACKBIRD
Box 8607, Dept. 311, Scottsdale, Az. 85252
TM © 1986 Blackbird Int'l. All Rights Reserved



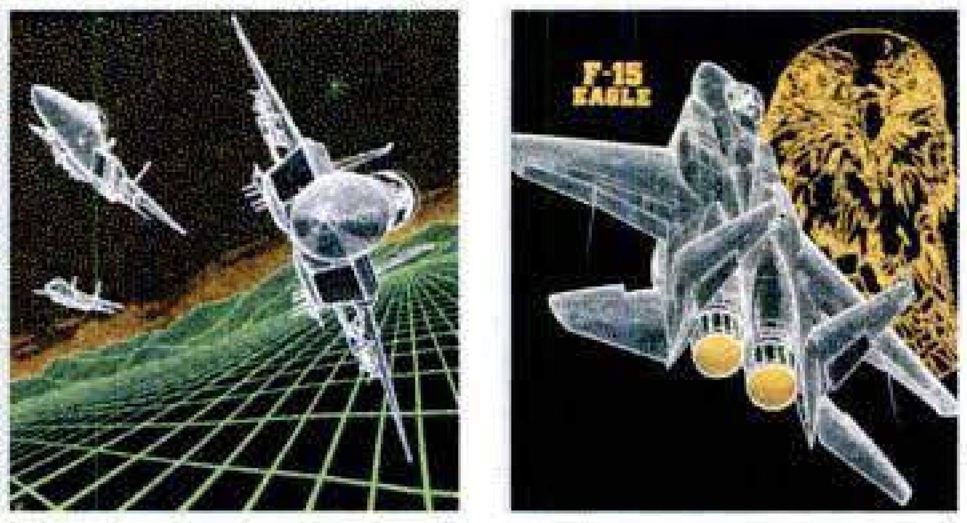
FRONT SPACE SHUTTLE BACK

FRONT BACK

FRONT BACK


MACH 3+
SR-71 BLACKBIRD

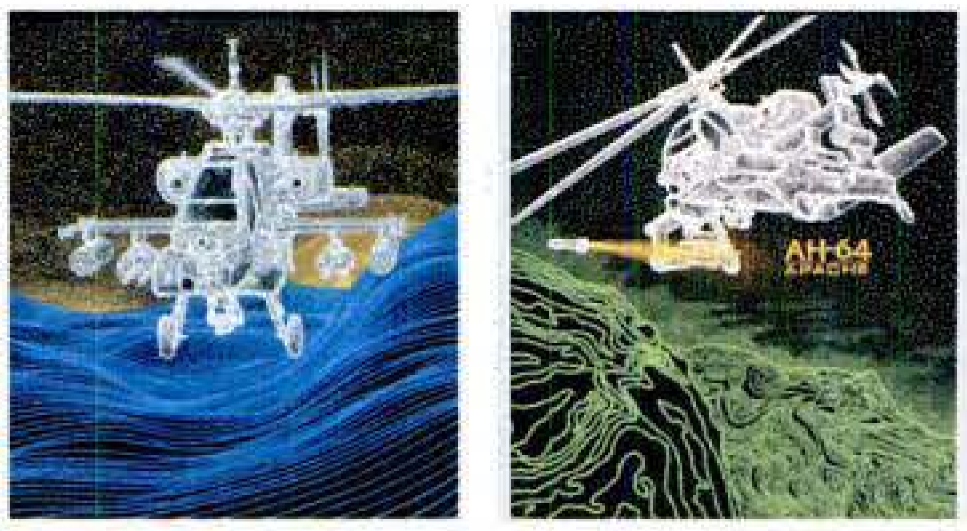
SR-71 BLACKBIRD NO. 1



F-15 EAGLE

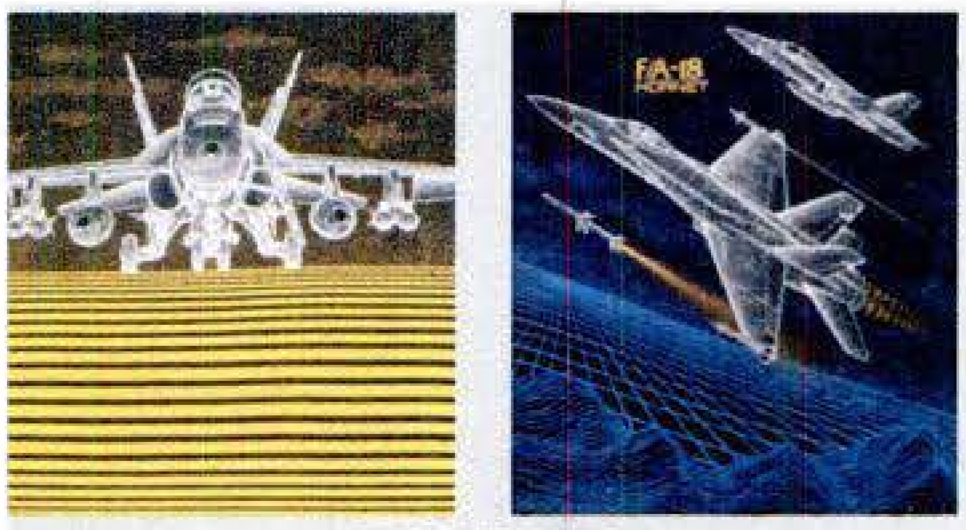
F-16 TACTICAL FIGHTER

B-1B STRATEGIC BOMBER

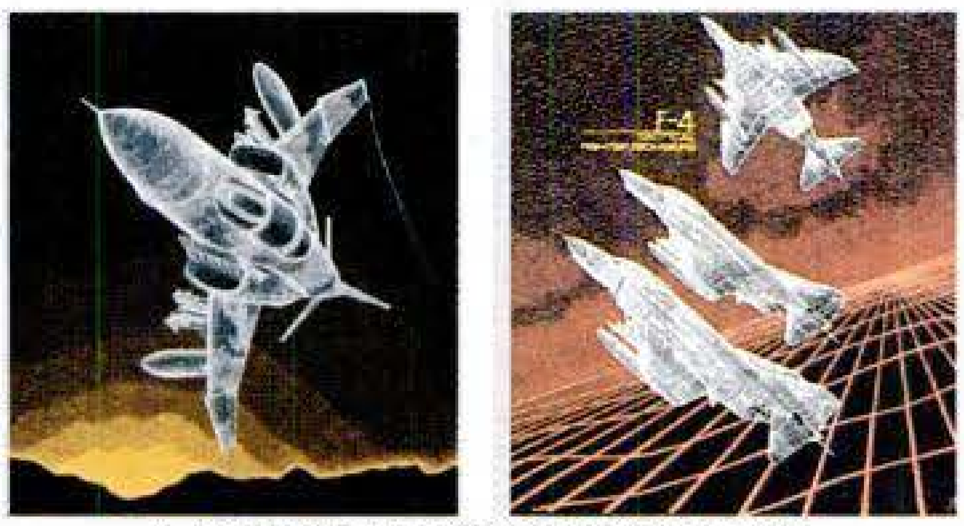

AH-64 APACHE

AH-64 APACHE

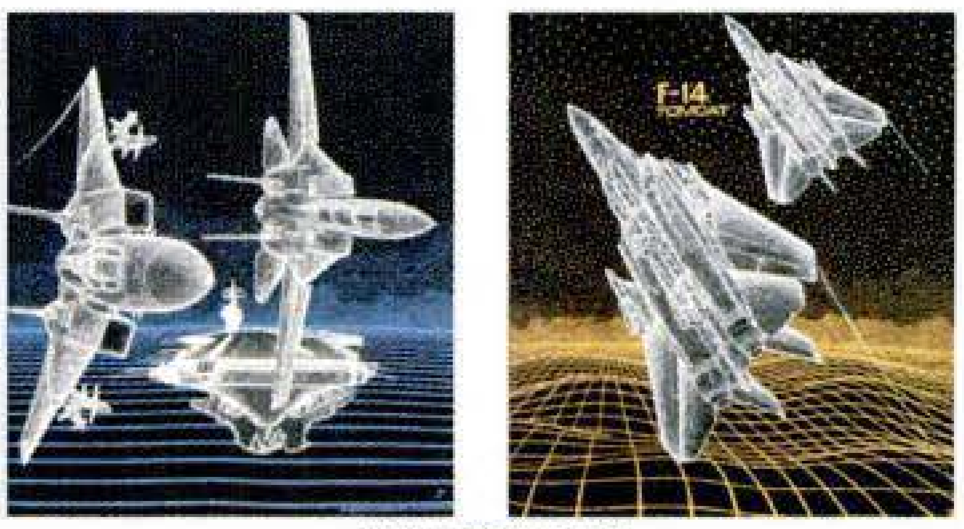
F-20 TIGERSHARK


FA-18 HORNET

F-18 HORNET



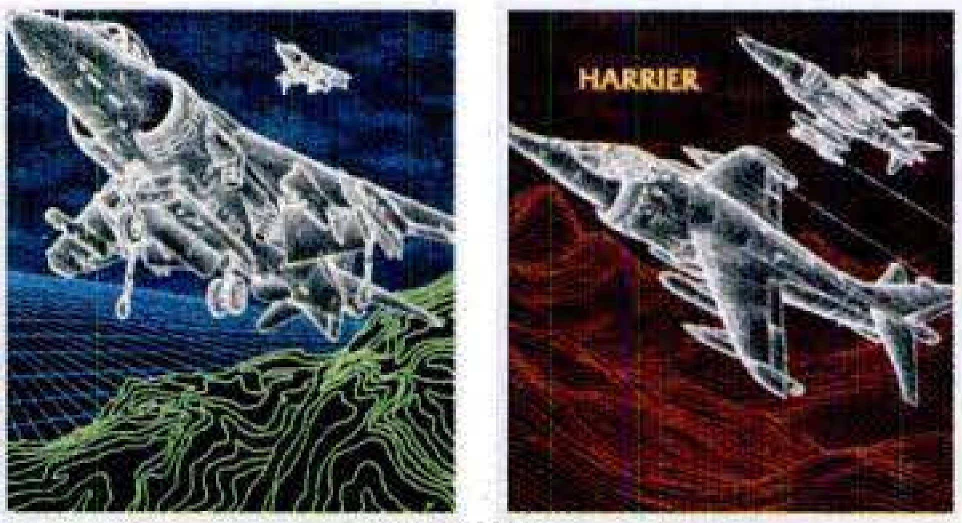
F-4 TACTICAL FIGHTER/BOMBER



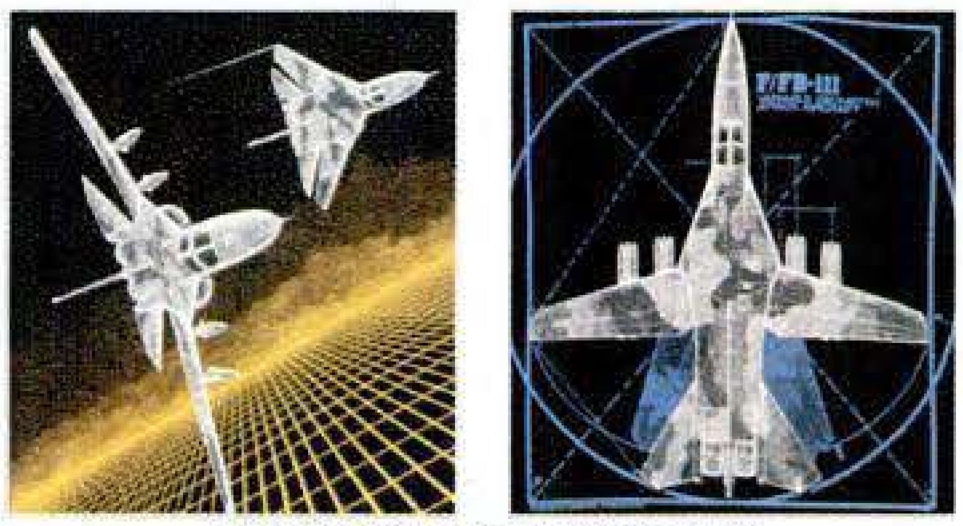
F-14 TOMCAT

A-10 THUNDERBOLT
NEW

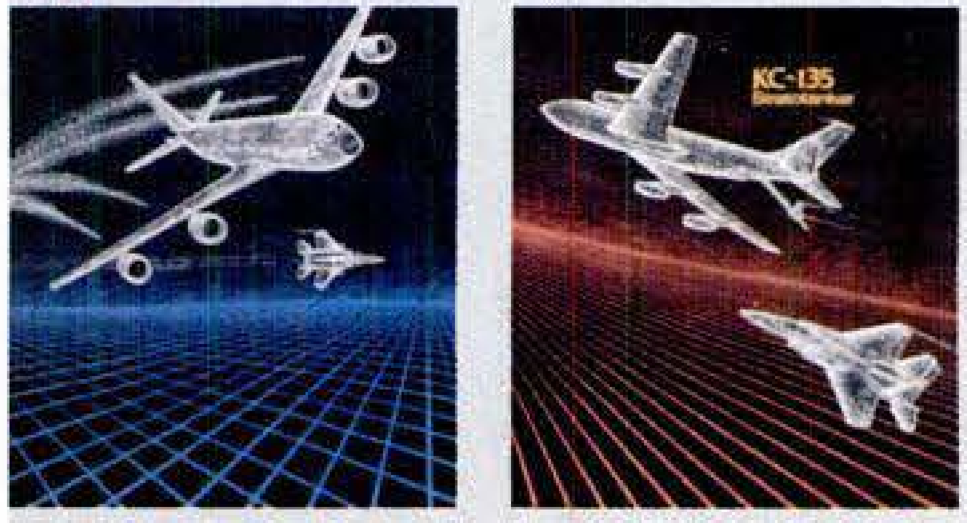
A-10 THUNDERBOLT



HARRIER



F/FB-111 FIGHTER/BOMBER

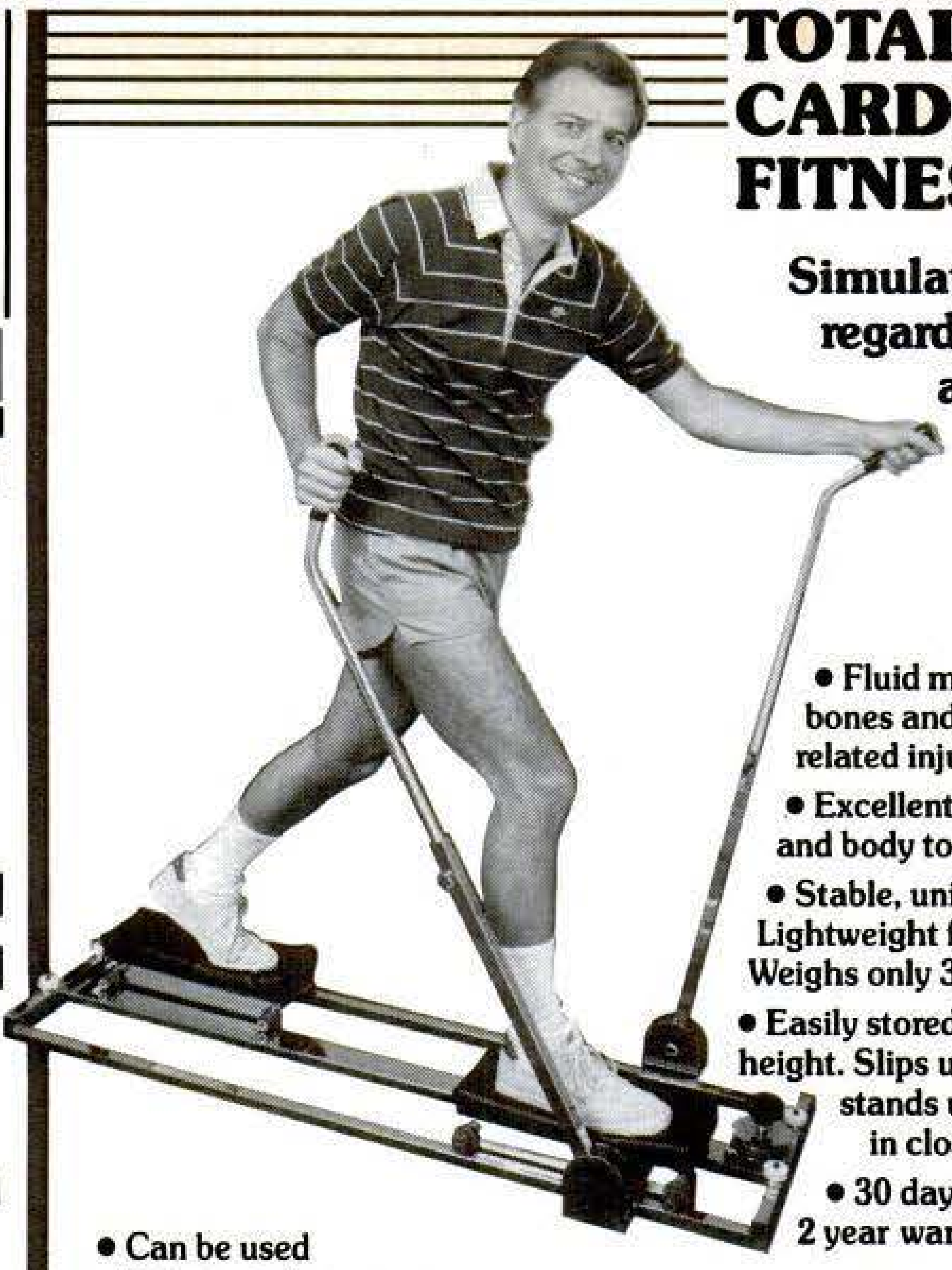


KC-135 STRATOTANKER

(actual shirt photos)

C-130 HERCULES

C-141 STARLIFTER



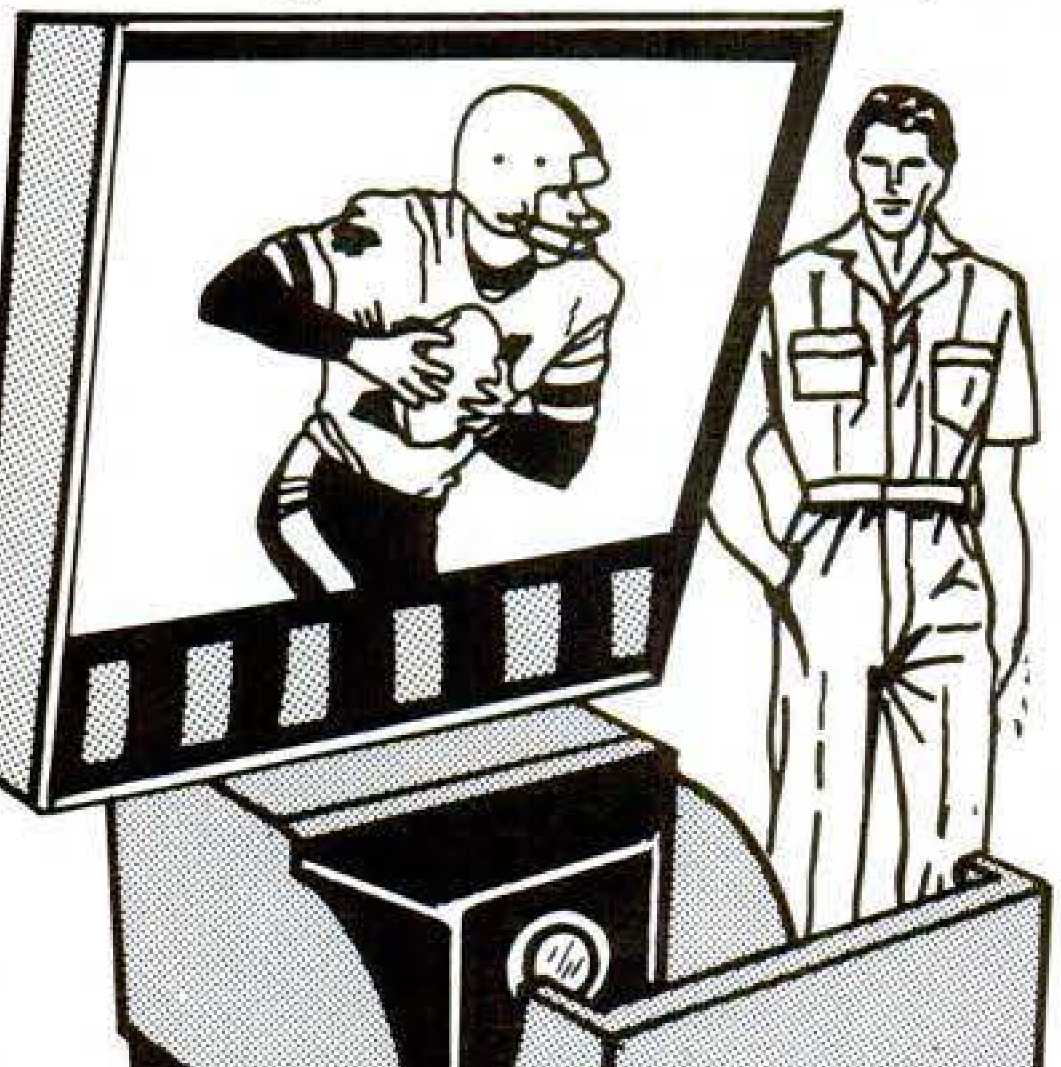
Fitness Master LT-35

TOTAL SYSTEM FOR CARDIOVASCULAR FITNESS.

Simulates cross-country skiing, regarded by fitness authorities as the top cardiovascular exercise. Rated higher than jogging, swimming, biking or rowing.

- Fluid motion — no jarring impact on bones and joints. Avoids running related injuries.
- Excellent for weight control and body tone.
- Stable, unit rests flat on floor. Lightweight for portability. Weighs only 35 lbs.
- Easily stored. Folds to 5 inch height. Slips under a bed or stands upright in closet.
- 30 day home trial. 2 year warranty.
- Can be used by men and women regardless of size or weight. Height and resistance adjustable.

For a Free Brochure call:
TOLL FREE 1-800-328-8995
In Minnesota 1-612-474-0992
Fitness Master, Incorporated
1387 Park Road Dept. PO
Chanhassen, Minnesota 55317



Amazing Lens Projects 5 ft. Picture

BUILD A BIG SCREEN T.V.

SPECIAL OFFER
$49.95 Value
ONLY $29.95

Including tube mounted lens, cabinet plans and specifications

Place 13"-15" portable TV set in cabinet, the lens will enlarge it to a Giant 5 ft. Diagonal picture.

Save $2,000.00 plus . . . Only $40.00 worth of common particle board, screws, nails, hinges and corner braces are needed to construct this cabinet. Finish to your choice of paint, stain, antique or decorative laminent.

Build yourself or have a cabinet shop do the work - either way, you can easily save up to $2,000.00 and more from store prices.

FREE . . . Design Plans, nationally advertised and sold for $15.00. Free with your lens system.

MONEY BACK GUARANTEE

If not satisfied for any reason, return within 30 days for a full refund.

UNIQUE GIFT ENT. PS 32
3862 E. Bay Dr., Ste. 184, Largo, FL 33541

UNIQUE GIFT ENT. PS 32
3862 E. Bay Dr., Ste.184, Largo, FL 33541

$20.00 VALUE COUPON

☐ Please rush Big Screen TV System, which includes: Tube Mounted Lens Assembly and Cabinet Model Design Plans ($49.95 value). Send $29.95 plus $3.00 shipping and handling. Total enclosed; $32.95. Florida residents add 5% sales tax.

NAME ____
ADDRESS ____
CITY ____
STATE ____ ZIP ____

PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Acura Integra LS	Toyota Celica GT-S	Volkswagen Scirocco 16V
Acceleration	5	5	5
Braking	2	3	2
Handling	5	5	5
Maneuverability	5	5	5
Quietness	3	3	2
Roominess	3	2	2
Vision	4	3	3
Entry/exit ease	2	2	2
EPA economy	4	4	4
Ride comfort*	3	3	2

*Authors' opinion

Scirocco drives the exhaust cam with a belt, then transfers motion from it to the intake cam via a chain. Also, VW shunned the conventional pentroof chamber used by Honda and Toyota (see box below). The goal, say VW engineers, was a narrower head for easier installation in front-drive cars.

Pedigree performance

With such exotic engines, we expected the cars in this trio to be quick. And they were. But it's a tribute to the engineering of everyday cars like the Civic, Camry, and Golf that the three also did so well in our handling tests, and were such fun in day-to-day driving.

The Acura was the slowest car from 0-to-60 mph, averaging 10.3 seconds, but we suspect Integra drivers won't care. The tiny four spun so smoothly to its 7,000-rpm red line, and the shifter was so light and precise, that the car felt faster than it was.

The Celica GT-S was almost a second quicker to 60 mph than the Integra. But the engine had that mechanical harshness found in many larger fours, which tended to discourage using engine speeds much above 4,500 rpm. It's a shame, too, as the Celica would pull willingly, if raucously, to its 6,800-rpm red line.

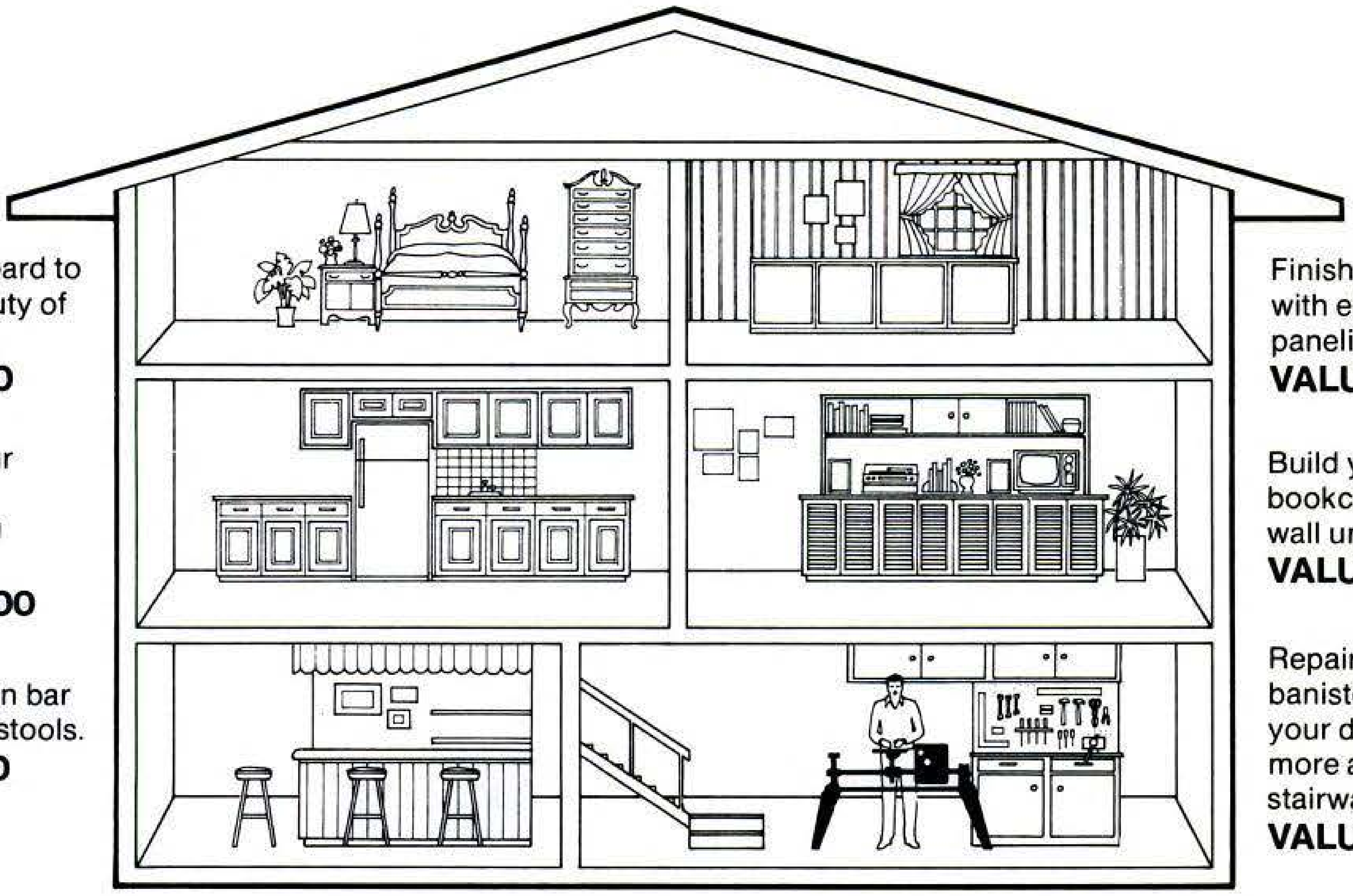
The Scirocco was the lightest car in the trio, and it proved to be the quickest, with 0-to-60 times averaging 8.8 seconds. (That's almost as quick as the IROC-Z Camaro PS tested last month.) Like the Celica, the engine pulled strongly to almost 7,000 rpm; there also was noticeable booming and resonance at higher engine speeds.

Modern manners

There are many cars that generate good numbers in PS track tests but

Continued

How to add thousands of dollars to the value of your home... by adding just one tool to your home workshop.



Build a headboard to add to the beauty of your bedroom.
VALUE $400

Customize your kitchen with cupboards you build yourself.
VALUE $2100

Design a built-in bar with matching stools.
VALUE $750

Finish your walls with elegant wood paneling.
VALUE $200

Build your own bookcase/stereo wall unit.
VALUE $650

Repair a loose banister. . . design your dowels for a more attractive stairway.
VALUE $350

The Shopsmith MARK V is the one power tool that can pay for itself!

When you want to add to the value of your home by doing repairs or remodeling — and you want it done right — you really only have three options:

1. Hire an expensive professional.
2. Buy a workshop full of top quality machines that can cost thousands.
3. Or, you can choose the Shopsmith MARK V — the professional quality home workshop that gives you the five most needed functions in one compact unit.

As you complete projects. . . adding beautiful custom-made kitchen cabinets. . . simple repairs to window sills. . . comfortable furniture you've designed. . . you'll watch your savings grow. In fact, in just one year's time you can save enough money to pay for your MARK V!

Save a bundle on equipment.

The Shopsmith MARK V is a remarkable piece of equipment that combines a 10" table saw, 16½" drill press, horizontal boring machine, 34" lathe and 12" disc sander all in one sturdy, freestanding floor unit. And because one rugged, self-cooling motor powers all five tools, you spend a fraction of what you'd expect to pay.

Perform over 150 woodworking operations with precision and accuracy.

The MARK V uses only one table, variable-speed motor and spindle to operate all five tools. . . and more! With our complete line of add-on tools and accessories you can complete over 150 different woodworking operations with maximum control and ease of workmanship.

QUALITY WOODWORKING TOOLS MADE IN USA
Shopsmith® is a registered trademark of Shopsmith, Inc.

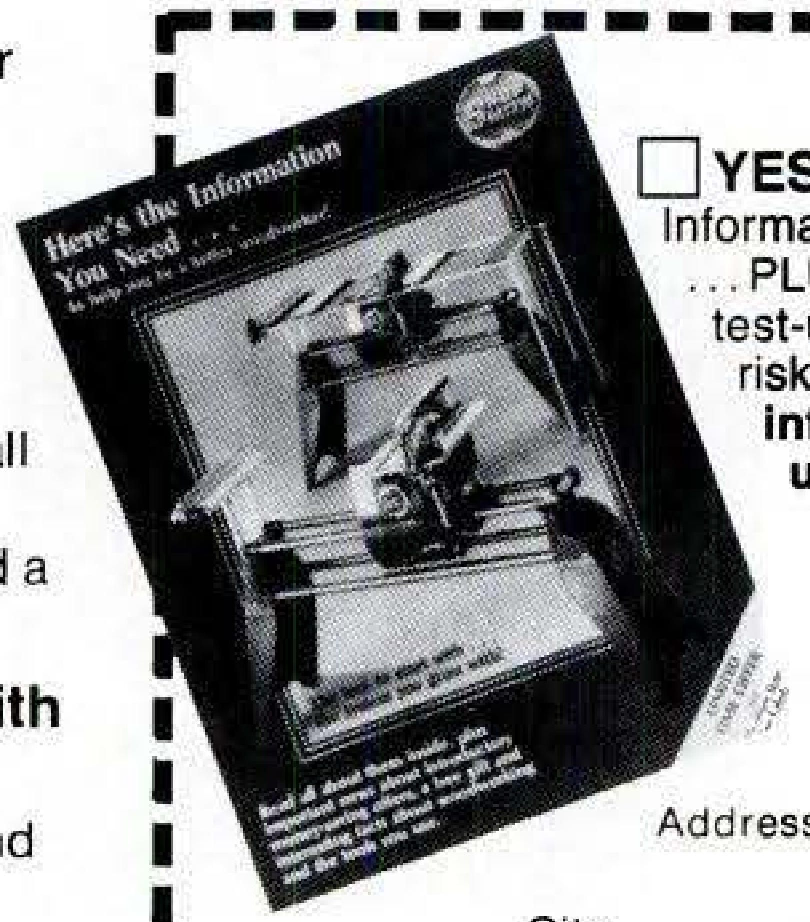
©Shopsmith, Inc. 1986

Find out more on how the MARK V can help add to the value of your home.

Call or mail this coupon today to get all the details on the amazing Shopsmith MARK V. We'll also tell you how you can try out the MARK V for 30 days, in your home, without risking a penny!

Call toll-free 1-800-228-2212
In Nebraska, 1-800-445-4000

Shopsmith Inc.
For better woodworkers
And those who want to be
6640 Poe Ave.
Dayton, Ohio 45414-2591



☐ **YES!** Please send me my FREE Information Kit on the Shopsmith MARK V . . . PLUS all the details on how I can test-use the MARK V at home, without risk, for 30 days, **I understand that this information is FREE and that I am under no obligation.**

Name____________________

Address____________________

City____________________

State____________ Zip________

☐ I currently own a Shopsmith woodworking tool. **Dept. 380B**

Shopsmith, Inc., 6640 Poe Ave., Dayton, Ohio 45414-2591

Copyrighted material

are difficult to drive well on the road. That's hardly a problem here. All three coupes were so well behaved that there was little to disturb those fantasies of winning the 24 hours of Le Mans.

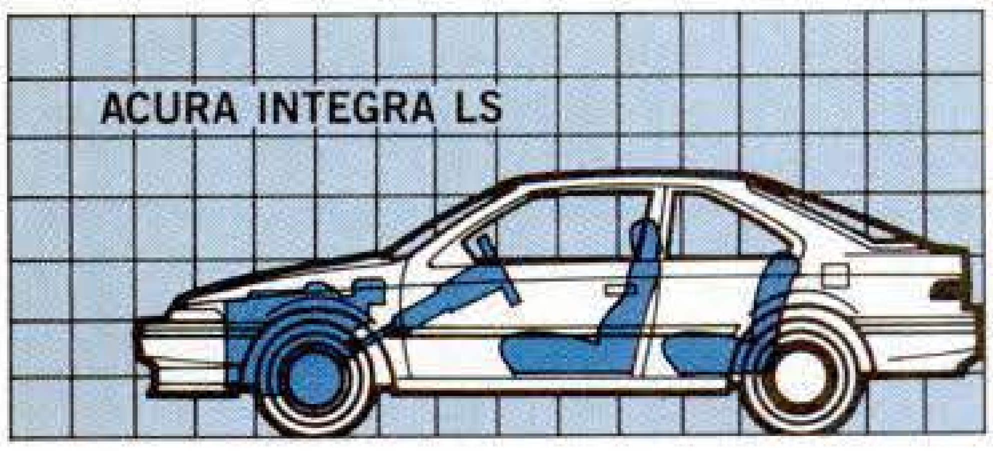
Driven well, the Integra was so smooth that it felt part of the driver. Controls were typically Honda—simple, solid, and logical—and the low belt line and large windows made the car feel smaller and lighter than it really was. The ride was firm but not harsh, and the chassis soaked up all but the biggest bumps. Even the back seat was a pleasant surprise, large enough to hold two adults for a short trip.

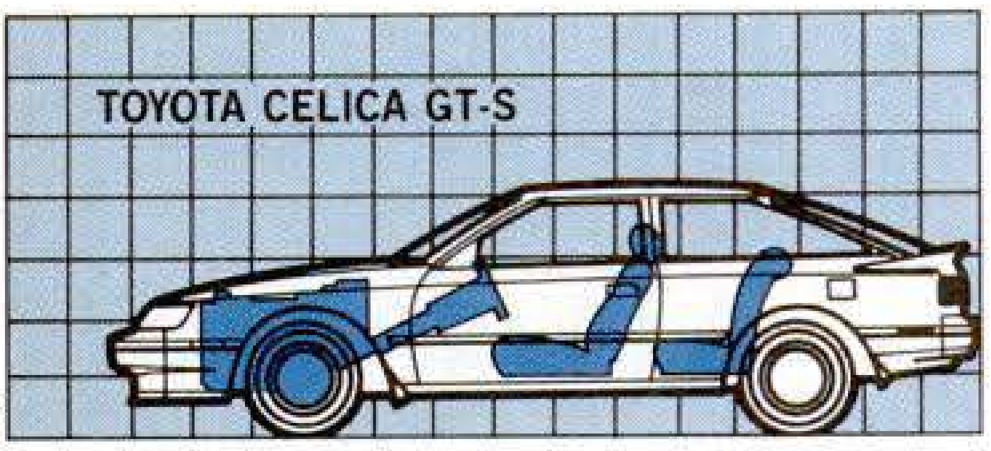
The Integra wasn't perfect, though. The cushion of the front seat was far too narrow, making some drivers squirm after just a few minutes on the freeway. The pedals were so close together they ensnared larger feet. On a sunny day, those large windows that made looking out such a joy also let in enough sun to seriously challenge the air conditioner. And a noticeable surge as the air-conditioning compressor cycled on and off seemed jarring when the engine was otherwise so smooth.

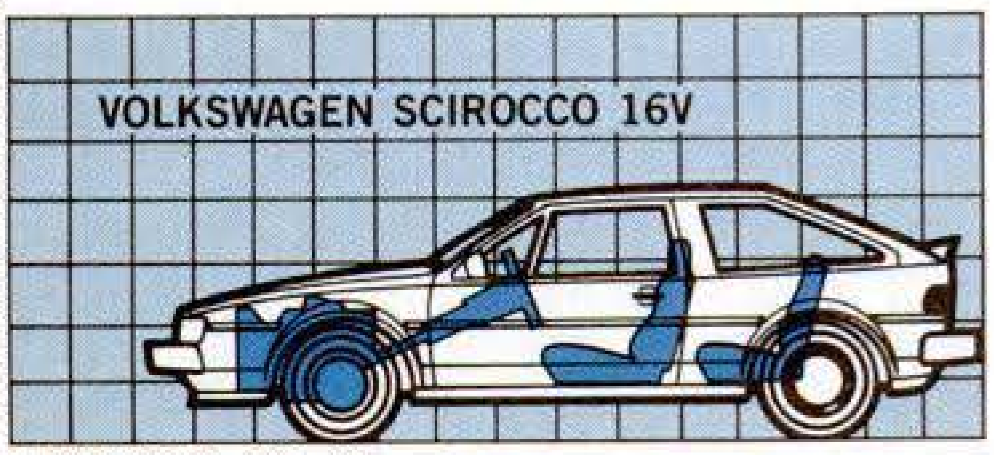
In contrast to the light, airy feel of the Integra, the low seats and high window sills of the Celica made the car feel a touch tanklike. Still, except for the already mentioned harshness at higher engine speeds, the car's manners were impeccable. The independent suspension was neither too soft nor too hard, and the Celica stuck equally well to smooth or bumpy turns.

The front seats were comfortable but not exceptional, while the back was a children-only zone. The gauges and

Continued







1 GRID BLOCK = 1 SQ. FT.

DRAWINGS BY RUSSELL VON SAUERS

POPULAR SCIENCE TEST RESULTS

TEST RESULTS	Acura Integra **LS**	Toyota Celica GT-S	Volkswagen Scirocco 16V
Acceleration (sec.)			
0–30 mph	3.4	3.1	3.0
0–60 mph	10.3	9.2	8.8
Brake test, 60–0 mph			
Stopping distance (ft.)	170	162	179
Pedal pressure, cold (lbs.)			
(0.5-G stop)	10	15	15
Pedal pressure, hot (lbs.)			
(0.5-G stop)	13	12	13
Handling test (mph)	71.7	69.1	68.8
Maneuverability test (mph)	31.6	30.8	29.4
Interior noise (dBA)			
At 30 mph	61	61	63
At 60 mph	69	70	69
EPA FUEL MILEAGE (mpg)			
Highway	30	29	28
City	26	23	23

Dimensions and specs

DIMENSIONS (inches)			
Wheelbase	96.5	99.4	94.5
Overall length	168.5	171.9	165.7
Overall width	65.6	66.5	64.8
Overall height	53.0	49.8	51.4
SPECIFICATIONS (as tested)			
Engine type	In-line 4	In-line 4	In-line 4
Displacement (cu. in./liters)	97/1.59	122/1.99	109/1.78
Compression ratio	9.3:1	9.2:1	10:1
Induction	E.F.I.	E.F.I	E.F.I
Net horsepower @ rpm	113 @ 6.250	135 @ 6,000	123 @ 5,800
Net torque (ft.-lbs.) @ rpm	99 @ 5,500	125 @ 4,800	120 @ 4,250
Transmission	5-speed manual	5-speed manual	5-speed manual
Final drive ratio	4.21:1	4.18:1	3.67:1
Steering	Power, rack-and-pinion	Power, rack-and-pinion	Power, rack-and-pinion
Turn diameter (ft.)	31.5	35.4	31.2
Front suspension	Struts with torsion bars	MacPherson struts, coil springs	MacPherson struts, coil springs
Rear suspension	Beam axle, coil springs	Dual-link, coil springs	Torson beam axle, coil springs
Brakes	Disc-disc	Disc-disc	Disc-disc
Curb weight (lbs.)	2,326	2,685	2,287
F/R weight distribution (%)	60/40	61/39	62/38
Fuel tank (gal.)	13.2	15.9	13.8
Trunk volume (cu. ft.)	16.0	15.7	19.3
Base price	$10,840	$12,348	$11,980
Price as tested	$11,545[1]	$15,858[2]	$13,780[3]

Major options: [1]A/C $653 plus installation; [2]sun roof $600, leather seats $715, A/C $855; [3]cruise control $210, stereo cassette radio $390, sun roof $450, A/C $750

Part prices

Part prices are manufacturers' suggested retail, rounded off to the nearest dollar

Brake pads, front	38	18	112
Brake pads/linings, rear	n.a.*	9	58
Front shock/strut insert	64	24	99
Alternator	140	214	519
Fuel pump	133	94	104
Ignition module	88	21	117
Grille	75	39	23
Front bumper	161	65	294
Windshield	234	133	211
Taillight lens	44	36	79

* Not available at press time

Serviceability ratings

Checking oil level	5	5	5
Checking coolant level	5	5	5
Adding oil	5	4	5
Changing oil filter	1	4	3
Changing spark plugs	5	5	4
Changing belts	2	2	3
Changing radiator hoses	4	4	4
Changing heater hoses	2	2	3
Checking fuses	4	4	4
Spare-tire access	4	4	4

(Ease of service: 5 = excellent, 1 = poor)

"Both exceed carmakers' warranty requirements. Texaco's Havoline does it for half the price."*

—BOB HOPE

Texaco's advanced formula Havoline Supreme challenges the world's most expensive motor oils.

Both Havoline and the expensive synthetics exceed car manufacturers' warranty requirements for virtually all gasoline-powered cars.

Both also meet or exceed industry standards for protecting your engine against wear, keeping it clean, saving gasoline and preventing rust and corrosion. But Havoline does those jobs for less than half the price.* Texaco's Havoline Supreme: high-quality protection *without* the high price.

Take the challenge wherever Havoline is sold.

*Based on average price for Mobil 1 and Havoline as reported by NPD-Auto Facts.

Havoline
Supreme
10W-30 MOTOR OIL
SAVES GASOLINE
QUART
0.946 LITER
Mobil
1
100% Synth
#1 in Performance and Pro
Motor Oil

EXTRA SAVINGS!

SAVE $3

on 12 quarts or $1.25 on 5 quarts. See participating retailers for details and rebate coupon. Hurry!

Offer ends Nov. 1, 1986.

controls were excellent, except for the cruise-control switch—one driver searched for several miles, one eye on I-80 and the other on the instrument panel, before he finally found it hidden on the right side of the radio.

For those with Porsche tastes and a Beetle budget, the Scirocco 16V may be the only hope. From the roar of the engine and crisp white-on-black gauges to the bare-bones interior and hard seat cushions, the Scirocco simply screamed "German sports car."

The 1.8-liter four pulled strongly from idle to red line, though the booming at higher engine speeds encouraged shifting sooner rather than later. The position of the seat, steering wheel, and controls was nearly perfect. Like the Celica, the back seat is child-size.

We didn't care for the Scirocco's orange upshift light, which kept nagging us to upshift just as the fun was starting. And we were disappointed to find a number of mechanical problems with our test car. Something in the shift linkage loosened up. The shoulder belt kept snagging the seat back release, and eventually pulled off its plastic cover. And the starter gave up the ghost, necessitating a tow to the dealer for repairs. Unfortunately, this was not the end of the VW's troubles. Supposedly fixed, the 16V was returned to us for further evaluation. It again failed us.

So there you have it, Mr. Mitty: three cars that can make a twisting mountain road more fun than Disneyland. We suspect the only people who won't enjoy the Integra LS, Celica GT-S, and Scirocco 16V are car makers that don't have a similar four-valve sport coupe on the drawing boards.

Testers' choices

With its delicate controls and nimble handling, the Integra is scarcely a car for the ham-handed. But it rewards smooth, skillful driving with some of the sweetest performance found anywhere. It's just that the narrow seat cushion caused a numbness in my backside, which kept disturbing my dreams of driving glory. I wonder, does wee Jackie Stewart ever have such problems?

The Scirocco lacks the Integra's polish. But its firm ride and willing engine make it a pleasure to drive briskly, and its German heritage make it the closest thing to a Porsche the average person can afford. If the quality of the test car had only been equal to that of the Japanese cars'...

After changing my mind several times, I finally settled on the Celica. It's not as responsive as the Integra, but it accelerates, handles, and brakes like a champ. With its excellent gauges, superb controls, and solid-as-a-rock Toyota feeling, the Celica GT-S is hard to beat.—T. W.

Trying to decide which of these spicey sportsters is best is like trying to decide among three of your favorite types of ice cream. Each has its own unique flavor. And all treat that hunger for something special and different. Unfortunately, most garages and budgets won't accommodate a triple scoop of sports car. The Scirocco seemed to be the most dedicated to being a sports car, with razor-sharp engine and handling responses. But along with this dedication were many of the compromises associated with sports cars—harder ride, engine noise, and an annoying number of interior trim pieces that were literally falling off. I liked the quiet, ride, handling, and power of the Celica GT-S, but the high belt line and tall instrument panel occasionally gave me the feeling I was driving a tank. If I have to choose, let it be the well-finished, comfortable-riding, smooth-running Acura.—J. J. K.

1 Clearing Edge
2 Cleaning Edge
3 Squeegee Edge
TRIPLEDGE
LIFETIME WIPER BLADE

THREE WIPING EDGES INSTEAD OF ONE!

- **The first edge removes the bulk of water or winter snow.**
- **The second edge removes bugs, road film, dirt.**
- **The third edge squeegees the glass completely clean.**

GUARANTEED FOR THE LIFE OF YOUR CAR. We guarantee Tripledge Wiper Blades for as long as you own your car! No other wiper blade can offer this guarantee. If you are not completely satisfied you get your money back.

THE WORLD'S FIRST SYNTHETIC WIPER. Tripledge blades are made from DuPont Nordel—the same material used in 50,000 mile radial tires. Tripledge wipers will never tear, crack, split, rot, dry out or stick. Not affected by ice, snow, blazing sun, smog or road chemicals.

EASY, DO-IT-YOURSELF INSTALLATION. Universal adapter snaps on; accepts bayonet, hook, pin type applications.

CUSTOM FIT for virtually every U.S. and import car, van or truck.

AIR-FLO DESIGN. Blades won't lift in high winds, high speeds. 6 claws grip firmly, distribute pressure evenly.

PATENTED DESIGN. Protected by U.S. Patent 4473919.

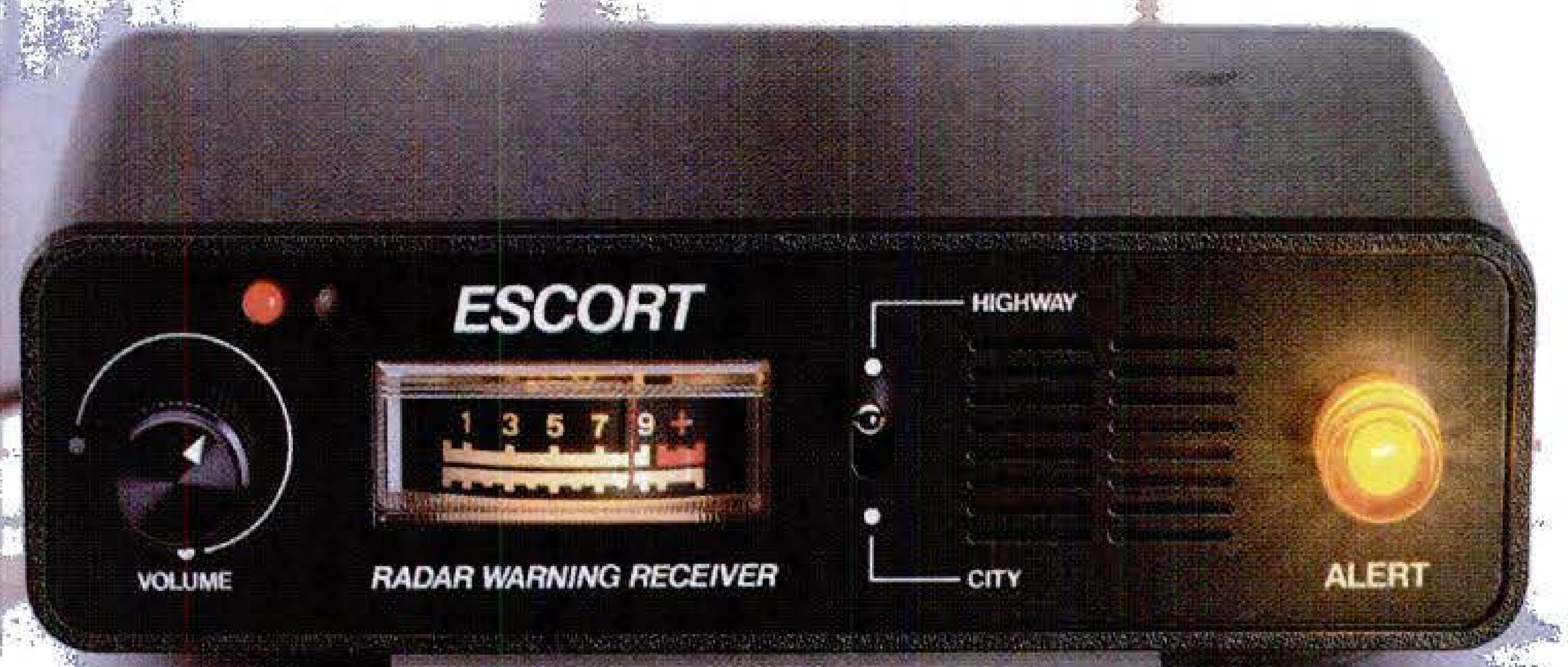
PRICE PER PAIR ONLY $9.95 + $1.95 shipping & handling. 2nd Pair Free Shipping! Specify make, model, year of car.

CALL TOLL-FREE 1-800-847-0653

or send check, money-order or card number and expiration date of your Visa or MasterCard. Pennsylvania residents add 6% sales tax.

TRIPLEDGE WIPER CORP., Dept. 108 P.O. Box 369, Bensalem, PA 19020

We can't name everyone who owns an ESCORT, but we can tell you why they do.



Steve Templeton
Dick Guldstrand
Don Swavely
Bobby Rahal
Anatoly Arutunof
Rocky Aoki
David Hobbs
Skip Barber
Yoshizo Shimano
Lyn St. James
Chris Mather
John Buffum
Grayden Obenour
Michael Kranefuss
Bob Sinclair
Hurley Haywood
Scott Hughes
Bill Mitchell
Reeves Callaway
Jon Lowe
Jim Fuller
Robert Redford
Bob Sharp
Bill Scott
Ron Forth
Vasek Polak, Jr.
Dave Wible
Jerry Wolf
Larry Shinoda
Jerry Galvin
Paul Naberhaus
Jim Trueman
William Hopkins
Don Knowles

Because radar is a problem, that's why. And ESCORT is the one detector they trust. Over a million motorists now concentrate on their driving and leave the radar worries to ESCORT.

Unsolicited Testimonial

In a test of all competing brands, the experts at *Car and Driver* magazine concluded that ESCORT **"is clearly the leader in the field in value, customer service and performance..."**

Chances are pretty good you know someone who owns an ESCORT. We've been around since 1978, which is an eternity in this business. So we'll stand on our reputation. Ask around.

Check Our References

We'll bet the first thing our customers will tell you is that ESCORT works. It finds all kinds of radar: X band, K band, over hills, around curves, moving mode, instant-on ambush. Whatever the trap, ESCORT finds it. And this long-range detection is followed up with a full report on the radar's strength. You can read this report on the analog meter. You can hear this report on the audio warning, pulsing slowly when the radar is weak, quicker as it strengthens, then constant as you approach range.

ESCORT even uses a separate warning tone for the two radar frequencies, "beep" for X band, "brap" for K band. The two radars behave differently. Trust ESCORT to keep you informed.

No False Moves

The second thing our customers will tell you is that ESCORT doesn't cry wolf. Our special ST/O/P™ (STatistical Operations Processor) circuitry recognizes and rejects the most common source of false alarms, the ones that set off less-sophisticated detectors up to a mile away.

A Dutch Uncle

The third thing our customers will tell you is that we make shopping easy. We sell direct from the factory only. Just dial toll free. No traffic delays. No parking hassles. No waiting for a salesman. Why wait for him anyway? He won't understand how radar works, so he can't be of much help with your problem.

Our sales staff are trained radar experts. They don't sell cameras and calculators too. Just radar detectors. They know the problems you face. And they're only a toll-free call away.

Our sales people won't give you the run-around if you ever need service after the sale either. They're here till 11:00 p.m. on weekdays and 5:30 on Saturday. Just call the same toll-free number.

Join the Club

It's easy to try ESCORT. Dial 800-543-1608. Delivery is as quick as UPS and we pay for shipping. If that's not fast enough, Federal Express guarantees 48-hour delivery for only $6.00 extra.

Take the first 30 days as a test. If you're not completely satisfied in that time, we'll refund your purchase and your return shipping. There are no hidden charges. We also back ESCORT with a one-year limited warranty on parts and labor.

Let ESCORT solve your radar problem. Judging by the owners we can mention, you'll be in good company.

Try ESCORT At No Risk

ESCORT $245 (Ohio res. add $13.48 tax)
Slightly higher in Canada

TOLL FREE 800-543-1608

VISA MasterCard

By mail send to address below. Credit cards, money orders, bank checks, certified checks, wire transfers processed immediately. Personal or company checks require 18 days.

ESCORT®
RADAR WARNING RECEIVER

Cincinnati Microwave
Department 0160
One Microwave Plaza
Cincinnati, Ohio 45296-0100

© 1986 Cincinnati Microwave, Inc.

NEW FREE BOOK DISCUSSES

HOW TO SELL YOUR INVENTION

Do you have an invention you intend offering to manufacturers on a sale or royalty arrangement? If so, by all means write for our free booklet as a guide, whether you do it yourself, or employ us to help you.

It's free for the asking and here are just some of the subjects it covers.

- **How to Describe Your Invention so Manufacturers will take Notice**
- **The Next Step to Take if a Manufacturer Shows Interest**
- **Approximate Royalty Rates Manufacturers are Currently Paying**
- **If Your Invention is Sold Outright for Cash**
- **Or, Part Cash, Part Royalty**
- **Submitting Your Invention Before Patenting**

Our reason for giving away information we've gathered over our 26 years in this business is simply that we hope you read it and employ us at our reasonable fee rather than do it yourself. But that will be for you to decide.

But understand, we are not promoters, developers, brokers. Ours is a technical service of writing descriptive materials for your invention and selecting the right manufacturers who potentially should be interested in it. The materials we prepare are your property.

We are not patent attorneys. For questions relating to proprietary rights, searches, patentability, you should consult a Registered Patent Attorney.

But back to the booklet. We want you as a client but only if, after reading it, you think you need us. Otherwise the booklet will show you how to do it yourself.

Use the coupon below. We'll rush the booklet to you. No obligation whatever. (But please no drawings or models at this point.)

REFERENCES: Your own bank, attorney or Chamber of Commerce.

Mail the coupon Today. Please enclose $1 for postage and handling. Kessler Sales Corp.,Dept. D-710 Fremont, Ohio 43420.

MAIL THIS COUPON

Mr. K. O. Kessler, President
Kessler Sales Corporation
Dept. D-710 Fremont, Ohio 43420

Please mail me the FREE booklet explaining how to go about selling my invention. This does not obligate me in any way. I am enclosing $1 for postage and handling, so rush the booklet by return mail.

Name________________________

Street Address____________________

City__________State______Zip______

Super-fast supercomputer

In a red-brick converted factory along the Charles River in Cambridge, Mass., at the offices of Thinking Machines, Inc., is a computer called the Connection Machine. It's not much to look at: a five-foot-tall, squeaky-clean black box. But inside the metal case are 65,536 separate processors that work together to solve a problem. Result: The Connection Machine is the world's fastest computer.

"Unlike a traditional computer that attacks a problem a step at a time," says inventor Danny Hillis, "the Connection Machine breaks a problem into thousands of extremely small pieces and solves them all simultaneously." The scheme, called parallel processing, isn't new, but until now even leading-edge prototype computers contained only 64 or fewer processors. The additional processors increase speed. "The Connection Machine handles a thousand MIPS [million instructions per second]," says Hillis. "That's four times quicker than the most rapid supercomputer to date."

Each processor contains a 4,096-bit memory that holds data and instructions, which can be updated or changed by another processor. "How the processors relate to each other depends entirely from one moment to the next on the stored information and the dictates of the software," says Hillis.

In one test of speed, the Connection Machine was used by Dr. Thomas Poggio, a scientist at the Massachusetts Institute of Technology and a leading figure in artificial intelligence, to measure the distances between a variety of objects laid out in a complicated random pattern. "We used two cameras to serve as the Connection Machine's eyes," Poggio told me. "The computer compared the scenes from the cameras and measured the disparities between them. From that, it computed relative depth and distance."

No other computer has accomplished the task in less than four hours. The Connection Machine finished all the computations in less than a second. "A traditional computer sees a scene slowly because it looks at the image one spot at a time," says Hillis. "The Connection Machine sees it all at once."

Developed by Thinking Machines, the Connection Machine took three years to build at a cost of $4.5 million.

—*Jeffrey Rothfeder*

Laser copier edits your work

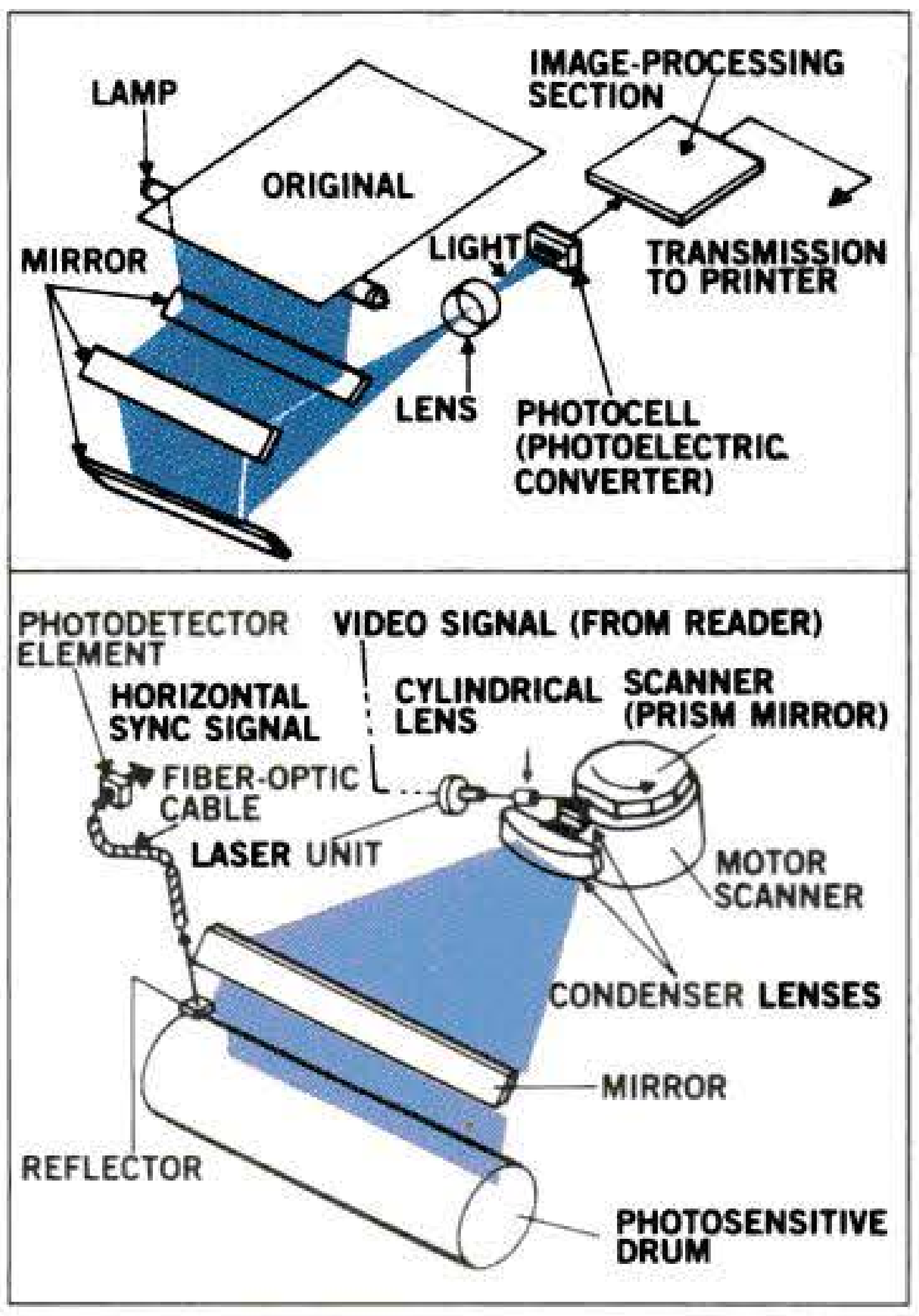
Morty Cohen, national sales training manager for Canon U.S.A., put a piece of paper in the top of the copying machine and pressed a button. Two seconds later, another sheet of paper emerged. But the copy from the Canon Laser system was different from the original: It had been edited.

Unlike other photocopiers, Canon's NP-9030 doesn't photograph the original document. "Instead," said Cohen, "it uses a photodetector to convert the original image into digital data—16 picture elements per millimeter—and a scanning laser beam to print the copy (see drawing)."

Because the image is digital, it can be shifted, enlarged or reduced vertically or horizontally, stored, and even edited before being duplicated. For example, I watched as Cohen placed on the copier a sheet of paper with nine boxes arranged in a tick-tack-toe pattern. He pressed an editing button, and the copy that emerged was identical—except that the center box was eliminated. The same technique can be used to edit text. What other tricks can it perform? "It doesn't matter where you place the original on the copier," he told me. "The machine centers the image on the copy."

Additional memory can be added to retain the image after one scan. That increases the copying speed from 30 copies per minute to 45 copies. The basic price of the NP-9030 is $11,000.

—*W. J. Hawkins*



NRI Trains You At Home—As You Build Your Own IBM-Compatible Computer

GET THE KNOW-HOW TO REPAIR EVERY COMPUTER ON THIS PAGE.

IBM
EPSON
AT&T
COMPAQ

IBM is a Registered Trademark of IBM Corporation.

Epson is a Registered Trademark of Epson America, Inc.

Apple and the Apple logo are Registered Trademarks of Apple Computer, Inc.

Compaq is a Registered Trademark of COMPAQ Computer Corporation.

© 1985 AT&T Technologies, Inc.

AND MORE.

Learn the Basics the NRI Way—and Earn Good Money Troubleshooting Any Brand of Computer

The biggest growth in jobs between now and 1995, according to Department of Labor estimates, will occur in the computer service and repair business, where demand for trained technicians will actually *double*.

You can cash in on this opportunity—either as a full-time corporate technician or an independent service-person—once you've learned all the basics of computers the NRI way. NRI's practical combination of "reason-why" theory and "hands-on" building skills starts you with the fundamentals of electronics, then guides you through advanced electronic circuitry and on into computer electronics. You also learn to program in BASIC and machine language, the essential languages for troubleshooting and repair.

Total Computer Systems Training, Only From NRI

No computer stands alone . . . it's part of a total system. To really service and repair computers, you have to understand computer *systems*. And only NRI includes a complete computer system as part of your training, preparing you for the real world of computer servicing.

You start with the step-by-step assembly of the highly rated, IBM compatible Sanyo 550 Series computer. You install and troubleshoot the "intelligent" keyboard. Then you assemble the power supply, install the disk drive and extra memory to give you a powerful 256K RAM system. Finally, you interface the high-resolution monitor and dot-matrix printer and begin to use the $1,000 worth of software that's included. You're learning about, working with, servicing and troubleshooting an entire computer system—monitor, keyboard, computer, disk drive, power supply, and printer—all the essentials you'll meet every day as a professional computer service technician.

No Experience Needed, NRI Builds It In

This is the kind of practical, hands-on experience that makes you uniquely prepared, with the skills and confidence you need for success. You learn at your own convenience in your own home. No classroom pressures, no night school, no need to quit your present job until you're ready to make your move. Your training is backed up by your personal NRI instructor and the NRI technical staff, ready to answer your questions and help you when you need it. You get it all from NRI!

100-Page Free Catalog Tells More

Send the postage-paid reply card today for NRI's big 100-page color catalog on NRI's electronics training, which gives you all the facts about NRI courses in Microcomputers, Robotics, Data Communications, TV/Audio/Video Servicing, and other growing high-tech career fields. If the reply card is missing, write to the address below.

Your NRI course includes the • IBM PC compatible Sanyo computer with memory expansion to 256K RAM • high-resolution monitor • double-density/double-sided disk drive • "intelligent" keyboard • dot-matrix printer with near-letter-quality mode • NRI Discovery Lab® to teach circuit design and operations • digital multimeter • logic probe • spread sheet • word processing software—and more.

NRI SCHOOLS

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue, NW
Washington, DC 20016

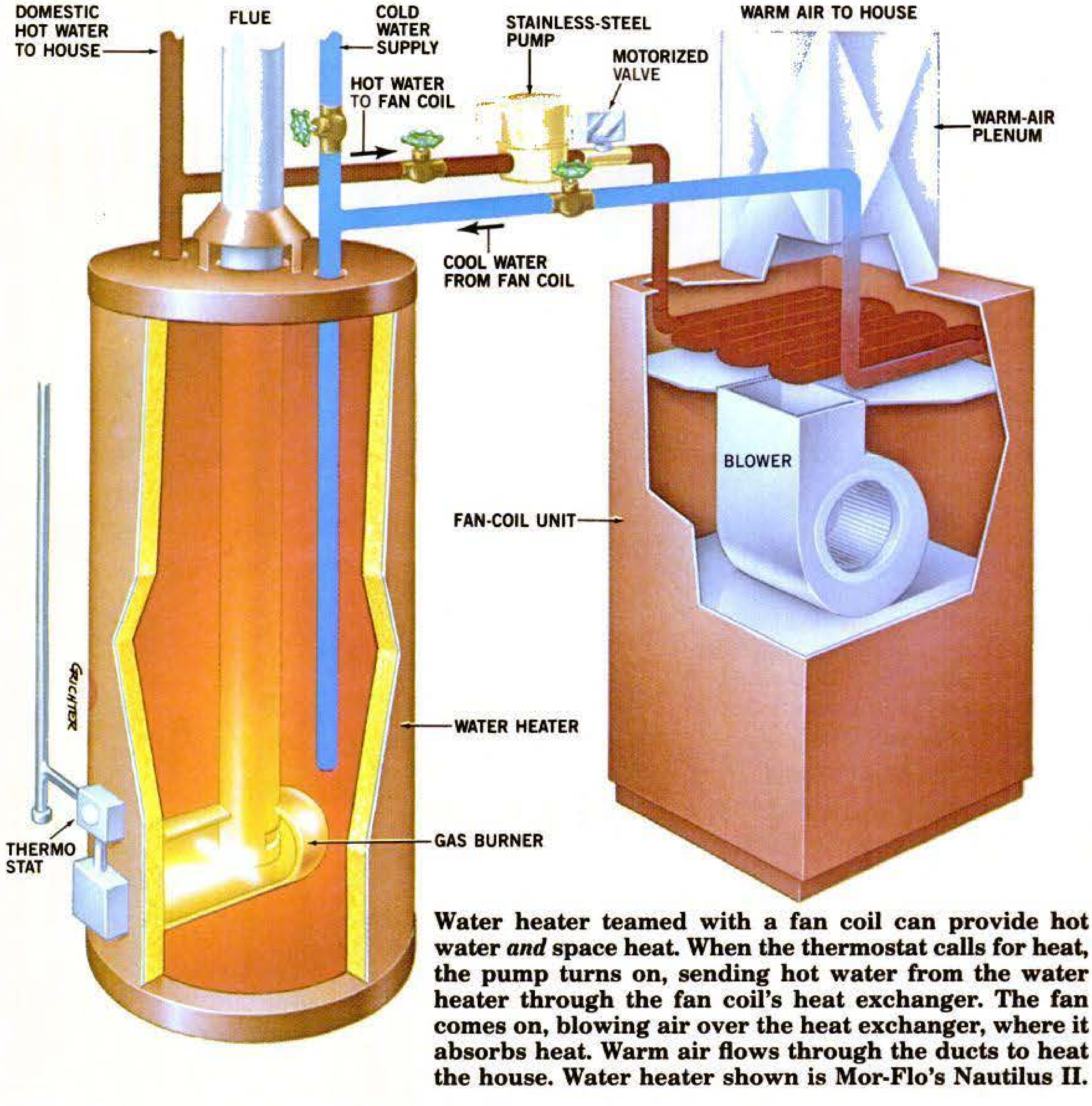
We'll Give You Tomorrow.

A PS SPECIAL SECTION

New products

HOME ENERGY

From innovative whole-house heating systems to small area heaters, from new insulation to cogeneration, you'll find a portfolio of products on the following pages. Perhaps there's just what you need to reduce heating bills and make your house cozier this winter.


DOMESTIC HOT WATER TO HOUSE
FLUE
COLD WATER SUPPLY
HOT WATER TO FAN COIL
STAINLESS-STEEL PUMP
MOTORIZED VALVE
WARM AIR TO HOUSE
WARM-AIR PLENUM
COOL WATER FROM FAN COIL
BLOWER
FAN-COIL UNIT
RICHTER
WATER HEATER
GAS BURNER
THERMO STAT

Water heater teamed with a fan coil can provide hot water *and* space heat. When the thermostat calls for heat, the pump turns on, sending hot water from the water heater through the fan coil's heat exchanger. The fan comes on, blowing air over the heat exchanger, where it absorbs heat. Warm air flows through the ducts to heat the house. Water heater shown is Mor-Flo's Nautilus II.

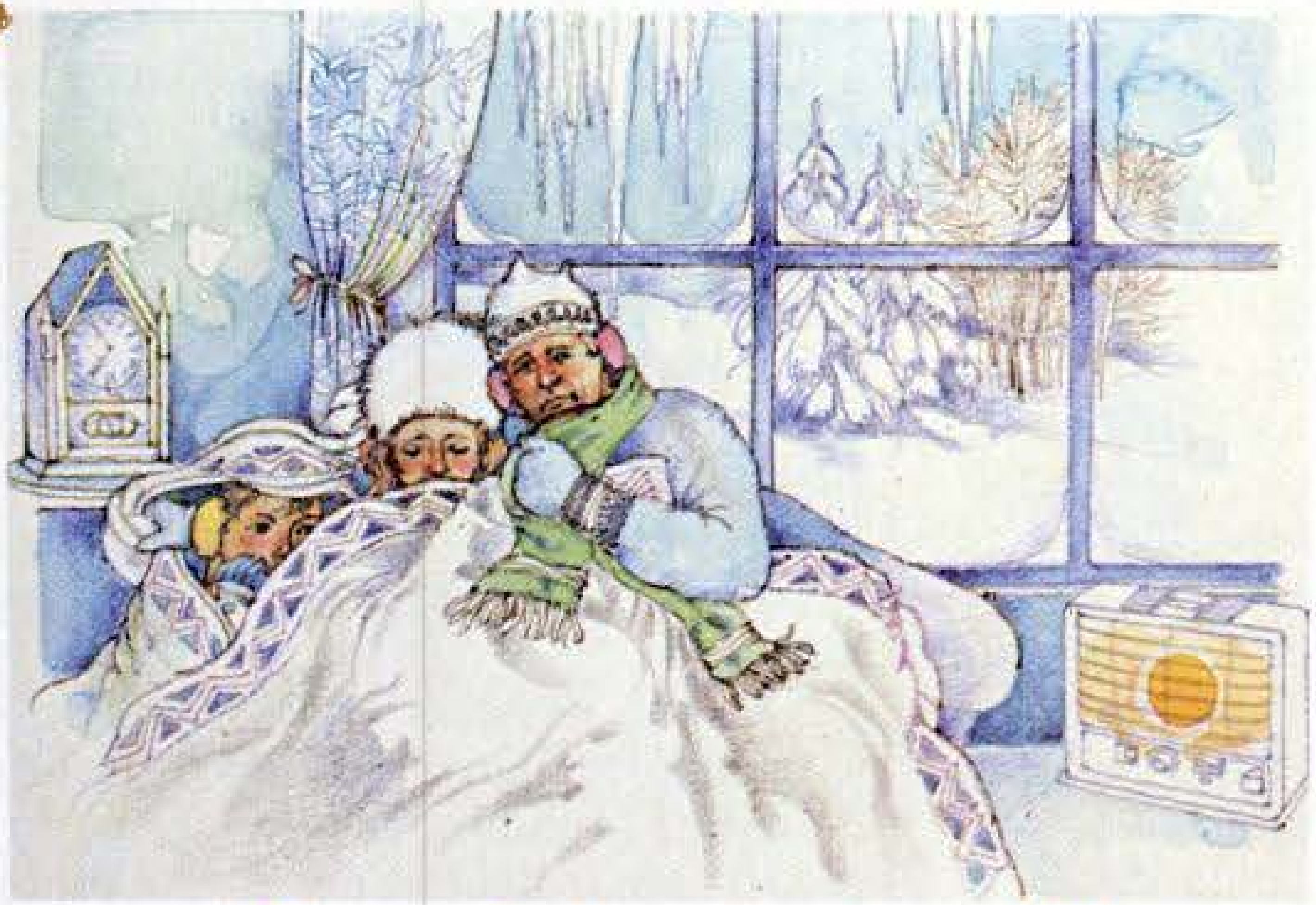
Heat your house with a water heater?

In 1979, Jim Whiting, a contractor in Raleigh, N.C., began installing space-heating systems that "borrowed" heat from standard gas water heaters. Others were probably doing the same, Whiting acknowledges, for the problem he faced was becoming common: As houses became tighter and better insulated, the amount of heat they needed dropped drastically. While a poorly insulated house might need a furnace that cranks out 100,000 Btu/h or more, many of today's well-insulated houses need

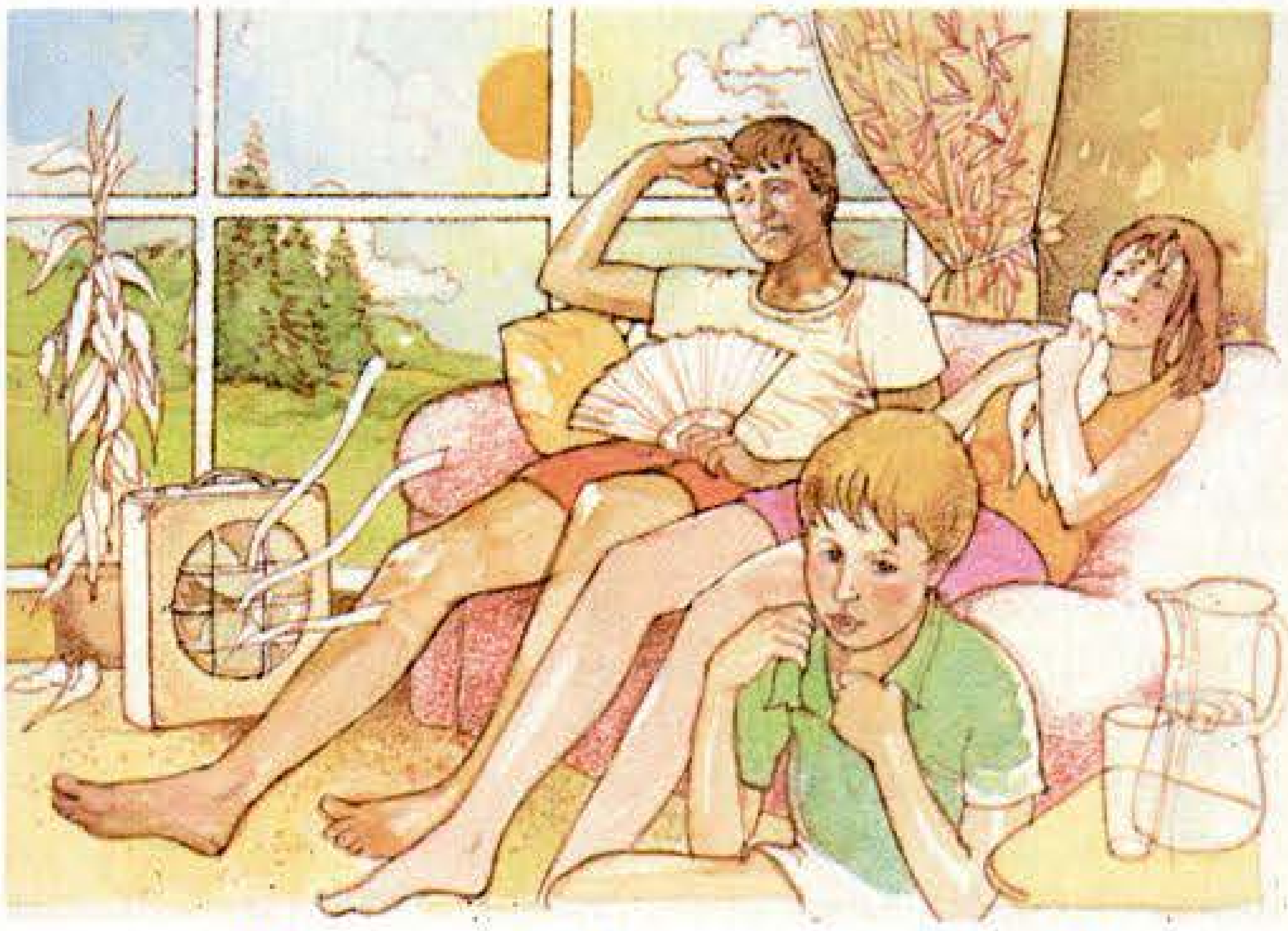
Continued

The insulator that really is a window.

or presenting Transparent Insulation from Ford Glass.



"Some windows are too cold."



"Some windows are too hot."

"Windows made with Sunglas® Heat Reflective™ glass are just right."

Some windows let precious warmth escape when it is cold outside and let in too much heat during hot weather.

But Sunglas HR glass lets the winter sun's heat inside and keeps it in. Also, the window surface will stay warmer reducing harmful condensation and drafts.

And in summer, when properly shaded, or when combined with Ford tinted glass products in sunny climates, Sunglas HR glass keeps the sun's heat out.

Sunglas Heat Reflective is a high-tech window glass that looks like clear glass but works like transparent insulation.

No matter what the season or time of day or night, double-paned Sunglas HR is 66% more efficient as an insulator than single glazing, 20% more efficient than old fashioned, ordinary double-paned glass* and it works even better in triple-glazed windows.

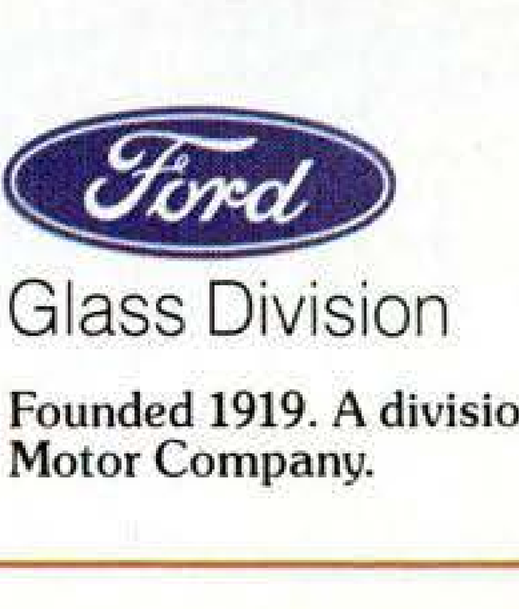
Even simple add-on storm windows with Sunglas HR can make your present windows work almost as well as new triple-glazed windows—if not better.

Sunglas HR makes great energy sense for sunspaces. In fact, the larger your glass area, the more you need Sunglas HR.

What's more, Sunglas HR reduces the sun's harmful ultra-violet rays that cause premature fading of household fabrics.

For your comfort and convenience, ask for Sunglas Heat Reflective glass by name. It's backed by a 5 year limited warranty from Ford Glass, the second largest glass manufacturer in North America.

When it comes to glass that works 24 hours a day, 365 days a year, every year—Nobody outglasses Ford.



See your local window supplier or for more information and a free brochure call **1-800-GLASS-HR** or write to:

Sunglas HR Manager
Ford Glass Division
Dept. **HR-7**
P. O. Box 43343
Detroit, MI 48243

Ford
Glass Division

Founded 1919. A division of Ford Motor Company.

---

*Based upon ½" air space. Performance will change with the width of the air space.

only 40,000 Btu/h or less. For superinsulated houses, that's true even in cold climates. Furnaces and boilers this small hardly exist.

Electric heat is one option, but rates in most areas make it a costly one to live with. Whiting saw another solution. A gas-, propane-, or oil-fired water heater only has to run a couple of hours a day to supply domestic hot water. By installing a water heater of somewhat higher heat output and having it work a little harder, Whiting reasoned, it could supply space heat as well.

The benefits: Without a separate furnace or boiler you save space and reduce complication, you'll probably lower energy costs, and you'll avoid uncomfortable temperature swings, a common problem when a furnace is too large.

To "borrow" space heat from the water heater, Whiting used a fan-coil unit (also called an air handler). Like a furnace, a fan coil has a blower, but instead of a burner, it has a fin-and-tube heat exchanger. Hot water from the water heater is piped through the tubes, and the fan sends warmed air through ducts to heat the house (see drawing, opening page).

Fan coils can be installed in the basement, a dropped ceiling, a closet —even in a wall. Put an evaporator coil below the blower and a condenser outside, and you have air conditioning.

Space heating with a water heater is increasingly popular; indeed it has spawned an industry:

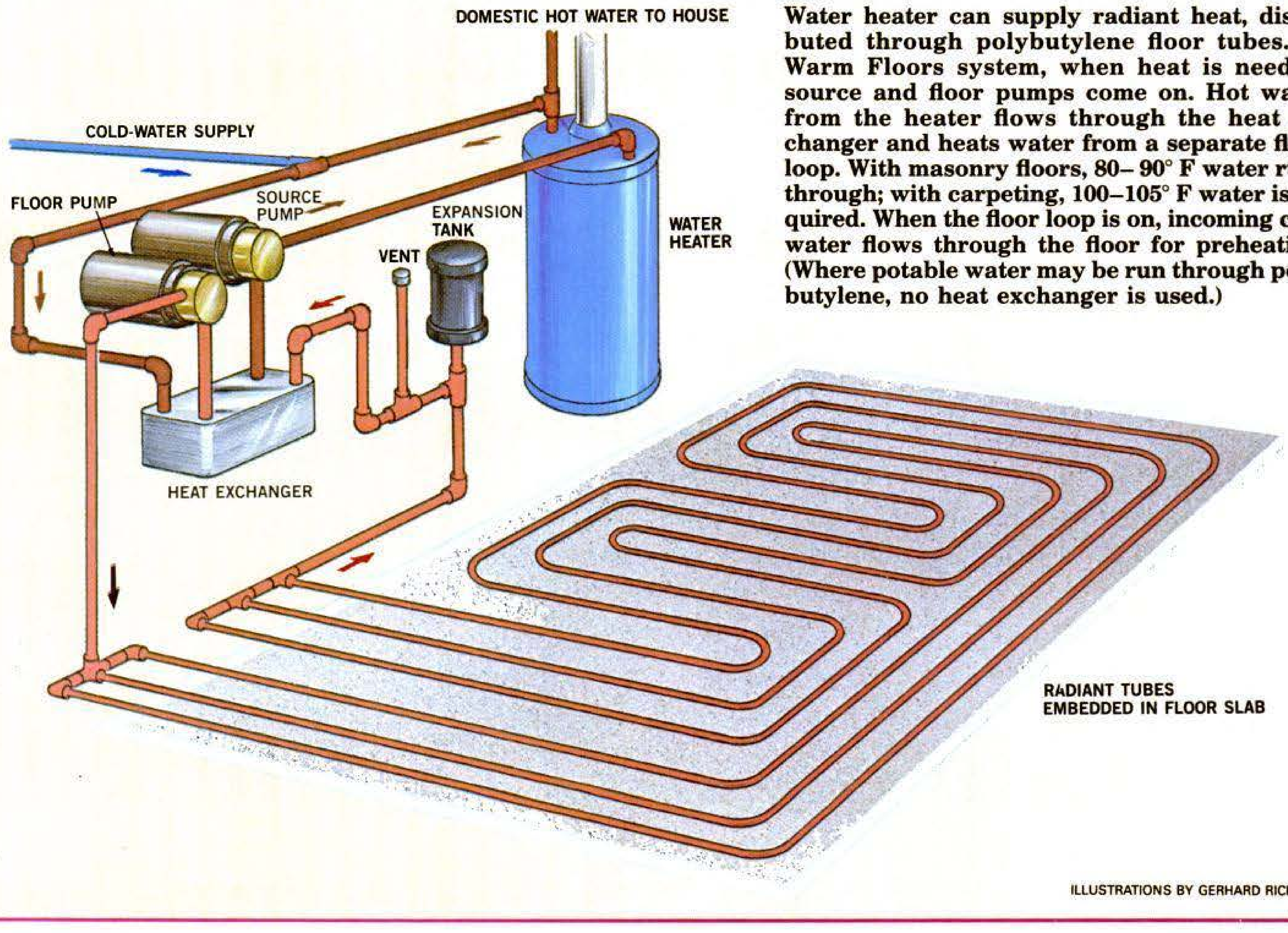
- Whiting's company, Apollo Comfort Products, makes a fan coil, the Apollo Hydro Heat, made to be used with water heaters, and a water heater made to mate with fan coils. The integrated Apollo Hydro Heat system comes in capacities up to 44,600 Btu/h.
- Mor-Flo Industries (Cleveland, Ohio), a major water-heater manufacturer, has also introduced integrated water/space-heating systems, called Mor-Flo/American Comfort Systems. That company's newest dual-purpose water heater, the Polaris, has an input capacity of 100,000 Btu/h and an efficiency of 94%.
- First Co. of Dallas, Texas, a large maker of fan-coil units for commercial buildings, has begun promoting the concept for homes, calling it the Aqua Therm Aire system.
- Fireless Furnace of Anaheim, Calif., makes fan coils specially for space heating with water heaters.
- Warm Floors of Napa, Calif., uses water heaters to provide radiant floor heat (see drawing below). Warm Floors sells its packaged pump-and-control module to other contractors.

Used conventionally, a water heater is notoriously inefficient, even when its recovery efficiency is high, because you end up using little of the heat it produces. (Recovery efficiency is the percentage of energy input that is delivered as heat to the water.) According to the Department of Energy, a water heater with a recovery efficiency of 75% has a yearly average efficiency of around 50%.

When you use a water heater for space heat as well, it runs more, but less of the heat is wasted. Thus its yearly efficiency can approach its recovery efficiency. That's one reason these integrated systems can reduce fuel bills.

Another reason: When you eliminate a gas furnace, you probably eliminate one standing pilot and one flue (which sends heated air up the chimney, even when the burner is off). "Generally an Apollo Hydro Heat system saves sixteen to twenty-three percent compared with a standard gas furnace and a gas water heater," Whiting says. Columbia Gas of Pennsylvania ran an independent, six-month test

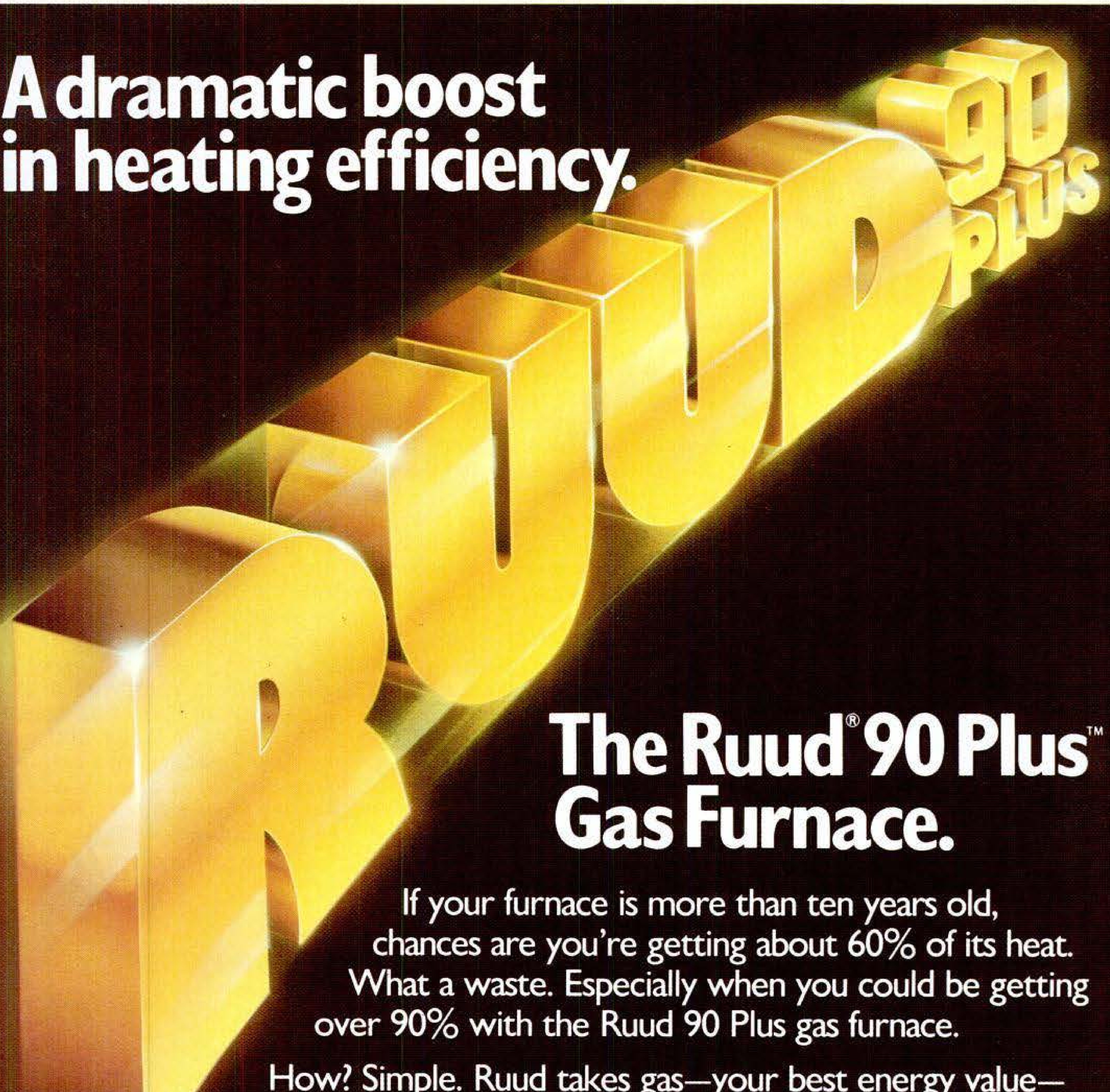
Continued



Water heater can supply radiant heat, distributed through polybutylene floor tubes. In Warm Floors system, when heat is needed, source and floor pumps come on. Hot water from the heater flows through the heat exchanger and heats water from a separate floor loop. With masonry floors, 80–90° F water runs through; with carpeting, 100–105° F water is required. When the floor loop is on, incoming cold water flows through the floor for preheating. (Where potable water may be run through polybutylene, no heat exchanger is used.)

ILLUSTRATIONS BY GERHARD RICHTER

A dramatic boost in heating efficiency.

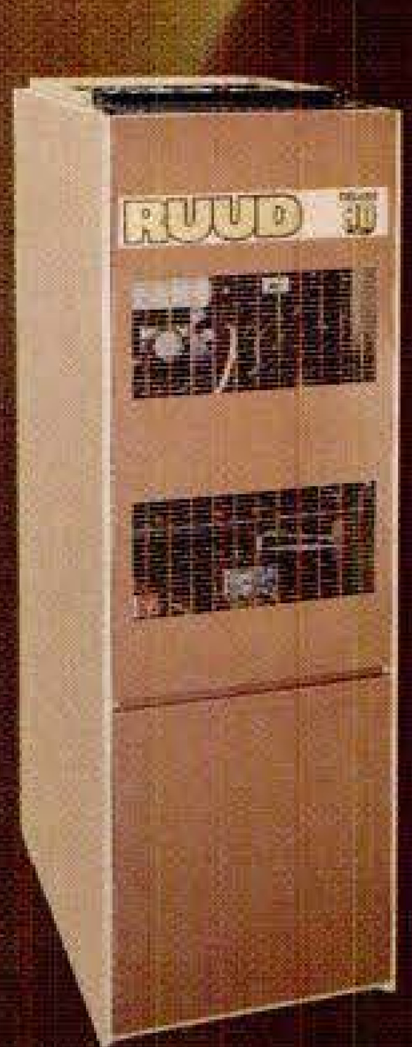


The Ruud® 90 Plus™ Gas Furnace.

If your furnace is more than ten years old, chances are you're getting about 60% of its heat. What a waste. Especially when you could be getting over 90% with the Ruud 90 Plus gas furnace.

How? Simple. Ruud takes gas—your best energy value—and makes it an even better value by capturing a whopping 90% of its heat. The result is a significant reduction in your fuel costs.

Why settle for 60% when you could have 90%? Check the Yellow Pages for your nearest Ruud dealer. He'll show you how much you can save with the Ruud 90 Plus gas furnace.



PERFORMANCE...

RUUD®

A WAY OF LIFE

Ruud Air Conditioning Division
5600 Old Greenwood Road—
Dept. A
Fort Smith, AR 72903

Gas. America's best energy value.

When you compare the costs of all energies, gas now gives you even more for your money.

© 1986 American Gas Association

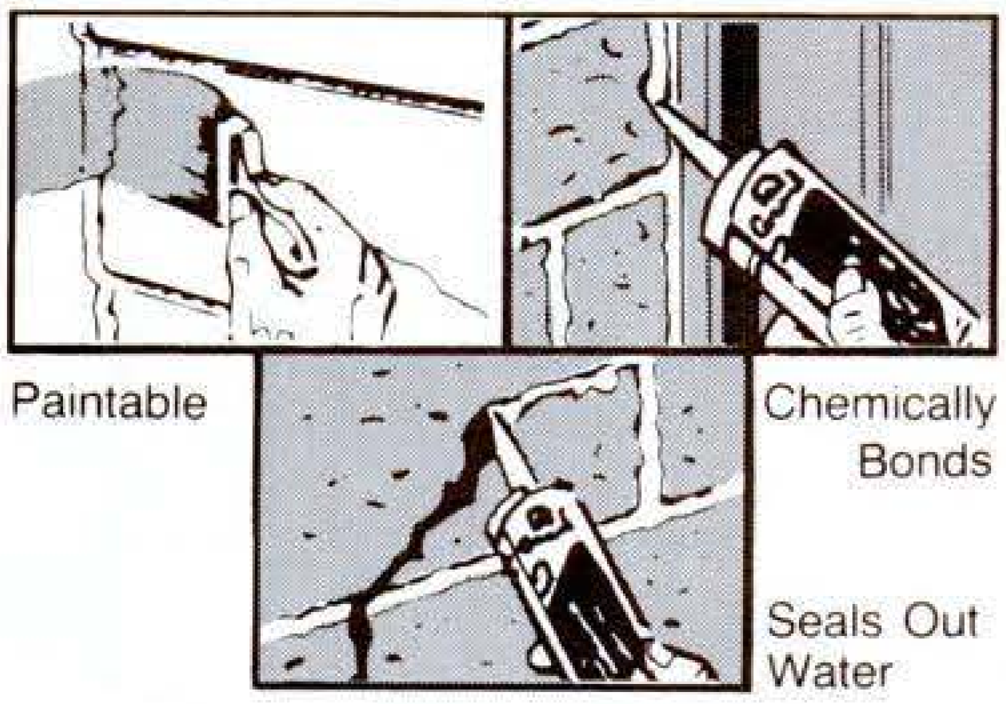
YOU MAY NEVER HAVE TO CAULK AGAIN!

- UV RESISTANT
- PAINTABLE
- STAYS FLEXIBLE
- LASTS OVER 30 YRS.

Geocel
Exterior
CAULKING
SEALANT
$2.00
REBATE
AT MAJOR
HOME CENTERS

Don't waste your time with caulks that crack and crumble away. Geocel Exterior Caulking Sealant has the flexibility, adhesion and UV resistance that gives you complete confidence in its durability. It will last for over 30 years.

IDEAL FOR..... VIRTUALLY ANY SURFACE



GEOCEL EXTERIOR CAULKING SEALANT

©1986 GEOCEL BUILDING PRODUCTS CORPORATION
P.O. Box 398 • Elkhart, Indiana 46515 • 1-800-348-7615

New products

HOME ENERGY

comparing an Apollo system with a conventional gas furnace and water heater. The result: a 16% saving with the Apollo.

Compared with an electric heat pump and electric water heater (prime competitors with water-heater/fan-coil systems) the dollar saving might be considerable, depending on local costs of gas and electricity.

Michael Luttrell, president of Warm Floors, claims 25%–50% savings with his system, based on the low gas bills reported by his customers. But no tests have been run.

Despite probable total savings, the water heater will burn *more* fuel than when it provides only hot water. "So choosing an efficient unit is much more important," Luttrell points out. He prefers water heaters with at least an 85% recovery efficiency. Others recommend 70% or better.

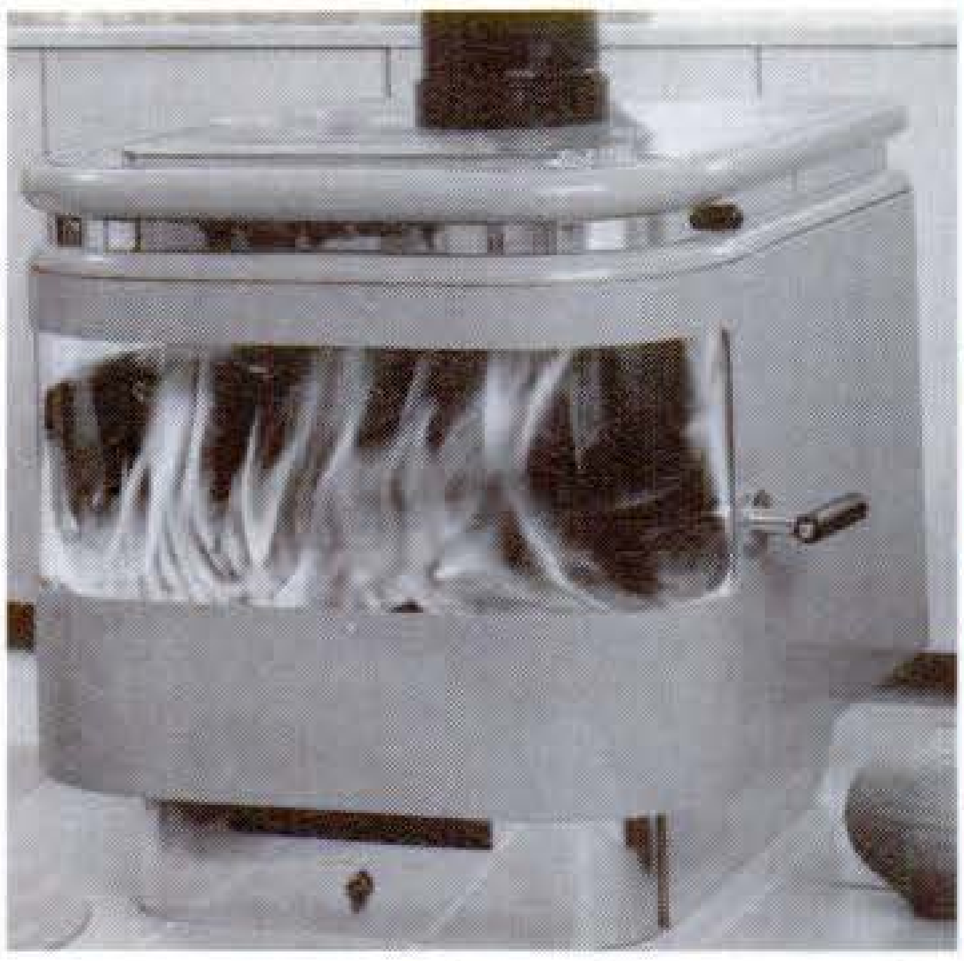
Installed costs of these integrated systems are competitive with those of an electric heat pump and electric water heater, or with a standard gas furnace and water heater—but not necessarily lower, most makers admit. An Apollo Hydro Heat system, including ductwork, generally costs about $1.25 for each square foot of floor space in the house you are heating, the company says.

Warm Floors systems average about $3 per sq. ft. of floor space. In California, reports Luttrell, that's competitive with other systems, at least for slab-on-grade construction.

"The combination of electricity, fire, gas, and scalding water is not a brew for amateurs," Luttrell cautions. Frank Stanonik, associate director of technical services for the Gas Appliance Manufacturers Assn., agrees. "Only engineered systems should be installed, and only by qualified installers," he advises.

One problem: hazardously hot water from household taps. A fan coil requires water of 130° F or higher. Thus a tempering valve must be put on the domestic water outlet.

Stanonik advises that you check with local officials before planning to install a water-heater-based heating system. The equipment mentioned is listed by the primary code bodies, but local jurisdictions have ultimate control.—*V. Elaine Gilmore*

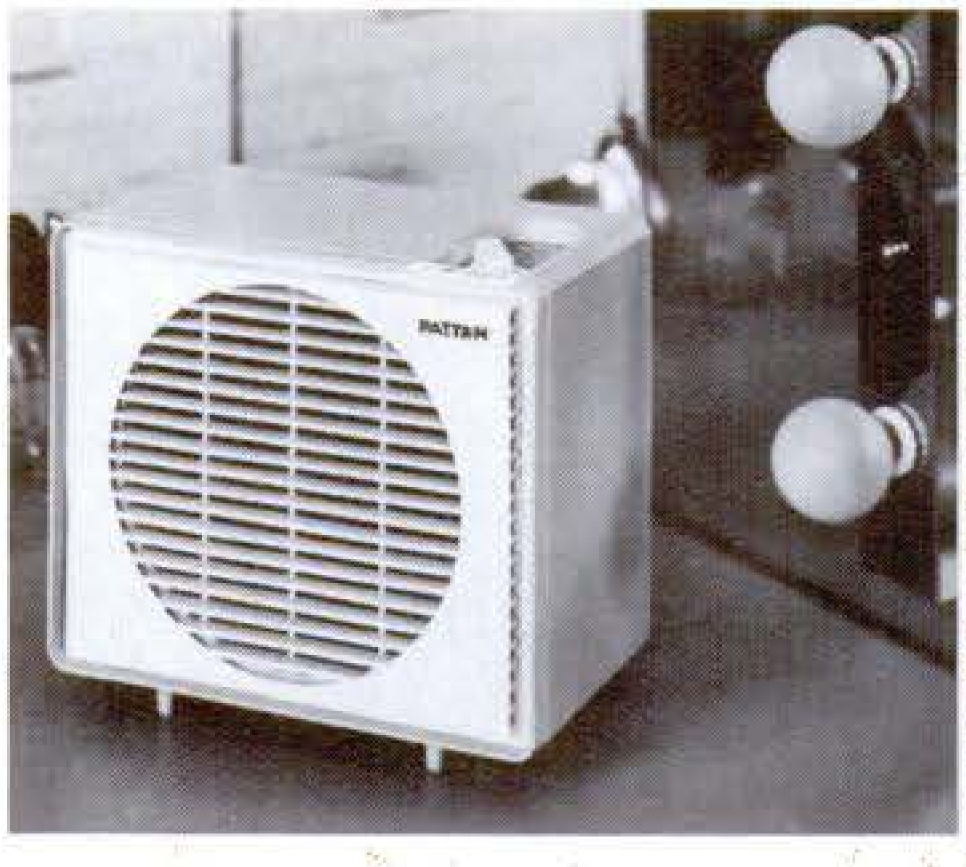


Clean lines, clean burner

If you like the idea of woodburning stoves but don't care for the way they look, the élan from Lopi Energy Systems (10850 117th Pl. N.E. Kirkland, Wash. 98033) may fit your fancy. Its smooth lines and expansive glass should compliment any room.

The élan meets both Oregon's and Colorado's tough anti-pollution standards. Preliminary tests rate its efficiency at 77%. A catalytic combustor ($200) further reduces emissions and boosts efficiency to 83%. The élan ($1,300) comes in black, blue, gray, or almond.—*N. Negovetich*

Unshocking news

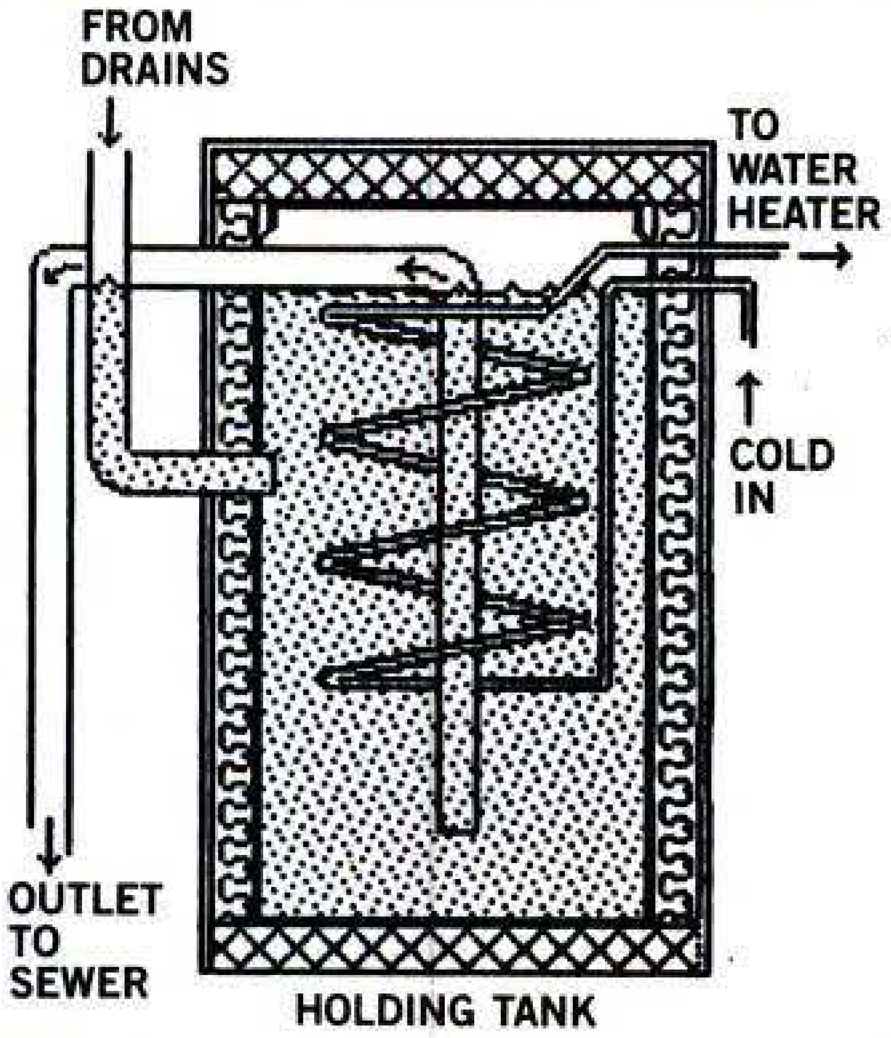


Having an electric heater in the bathroom is a safety concern for most people; controlling odors and mildew there can be another problem. Enter the Bathroom Heater Plus by Patton Electric (Box 128, New Haven, Ind. 46774). Its special internal sensor turns the unit off if it's dropped in water, reducing the risk of electric shock. It also has an air filter that traps bacteria, molds, dust, and fungi commonly found in bathrooms.

The 3-lb. unit is $40, and will be sold through retail outlets. UL listing is pending.—*Sherrill Clarke*

New products

HOME ENERGY



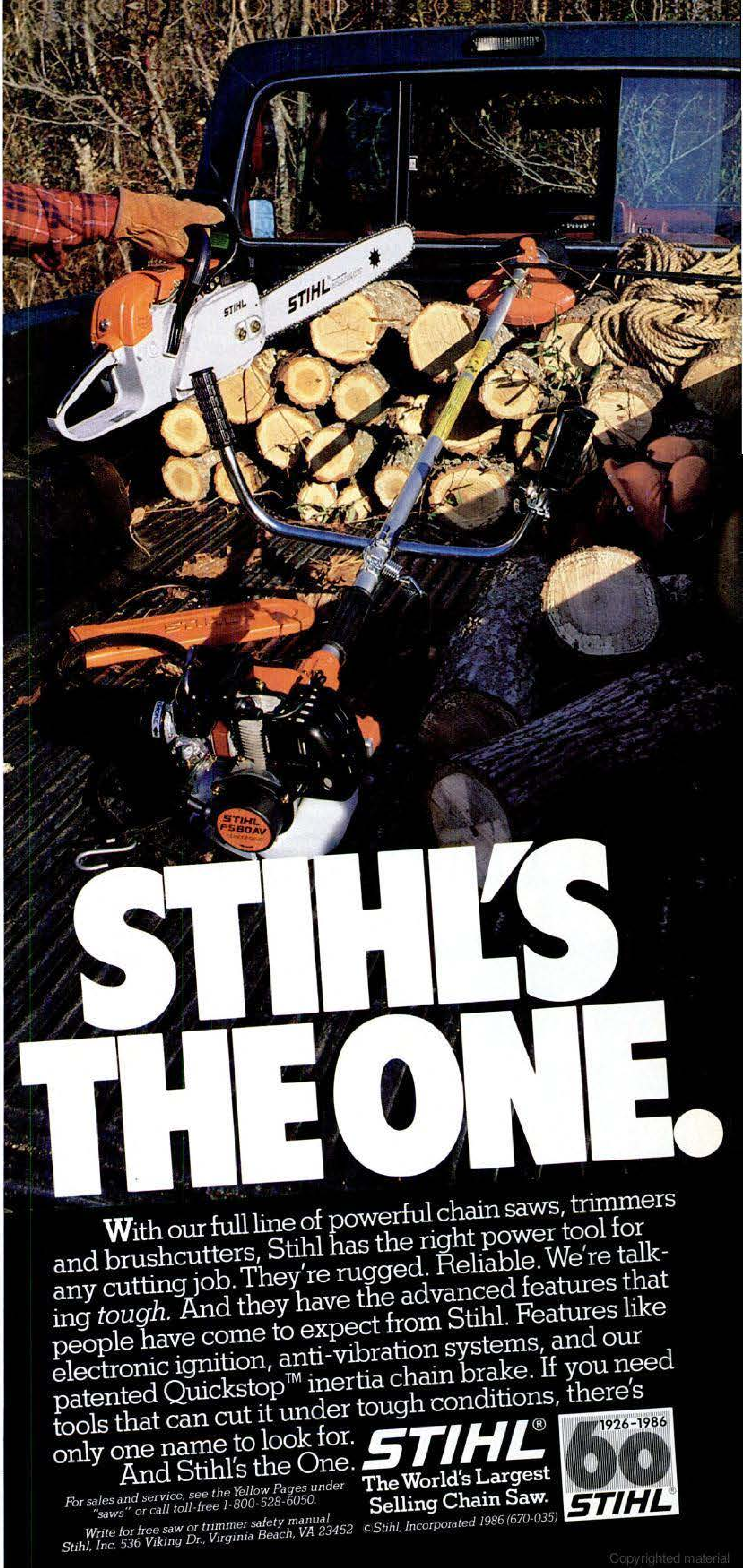
Clean heat from dirty water

When Ken Thompson takes a shower, he stands under a stream of fresh water that has been preheated by the sudsy water spiraling down his drain. Thompson is vice president of marketing for Earthstar Energy Systems, maker of a "gray-water" heat reclaimer. It recaptures energy from waste water that is ordinarily dumped directly into the sewer system. The $350 unit cuts water-heating bills by an average of 40 percent, the company says.

Selected drain lines from hot-water sources like dishwashers, baths, and hot-cycle wash loads are routed through an insulated plastic tank. A heat exchanger (two coils of ½-inch-thick polybutylene tubing) carries cold, fresh water through the 50-gal. tank, where it picks up heat from the gray water. Pre-warmed, it flows on to the water heater. The coils are near the top, where the warm water enters; colder water from the bottom of the tank flows into the sewer.

Earthstar (14 Jefferson St., Waldoboro, Maine 04572) first used polybutylene tubing in solar heating systems. Because it is seamless and cannot corrode as does metal, the tubing prevents accidental mixing of gray and fresh water, Thompson notes.

A capful of biodegradable liquid dumped down the shower drain once a month will remove buildups of soap sludge and hair, says Thompson. But do not connect the tank to kitchen sinks with garbage disposers, he warns.—*Dawn Stover*



With our full line of powerful chain saws, trimmers and brushcutters, Stihl has the right power tool for any cutting job. They're rugged. Reliable. We're talking *tough.* And they have the advanced features that people have come to expect from Stihl. Features like electronic ignition, anti-vibration systems, and our patented Quickstop™ inertia chain brake. If you need tools that can cut it under tough conditions, there's only one name to look for.

And Stihl's the One.

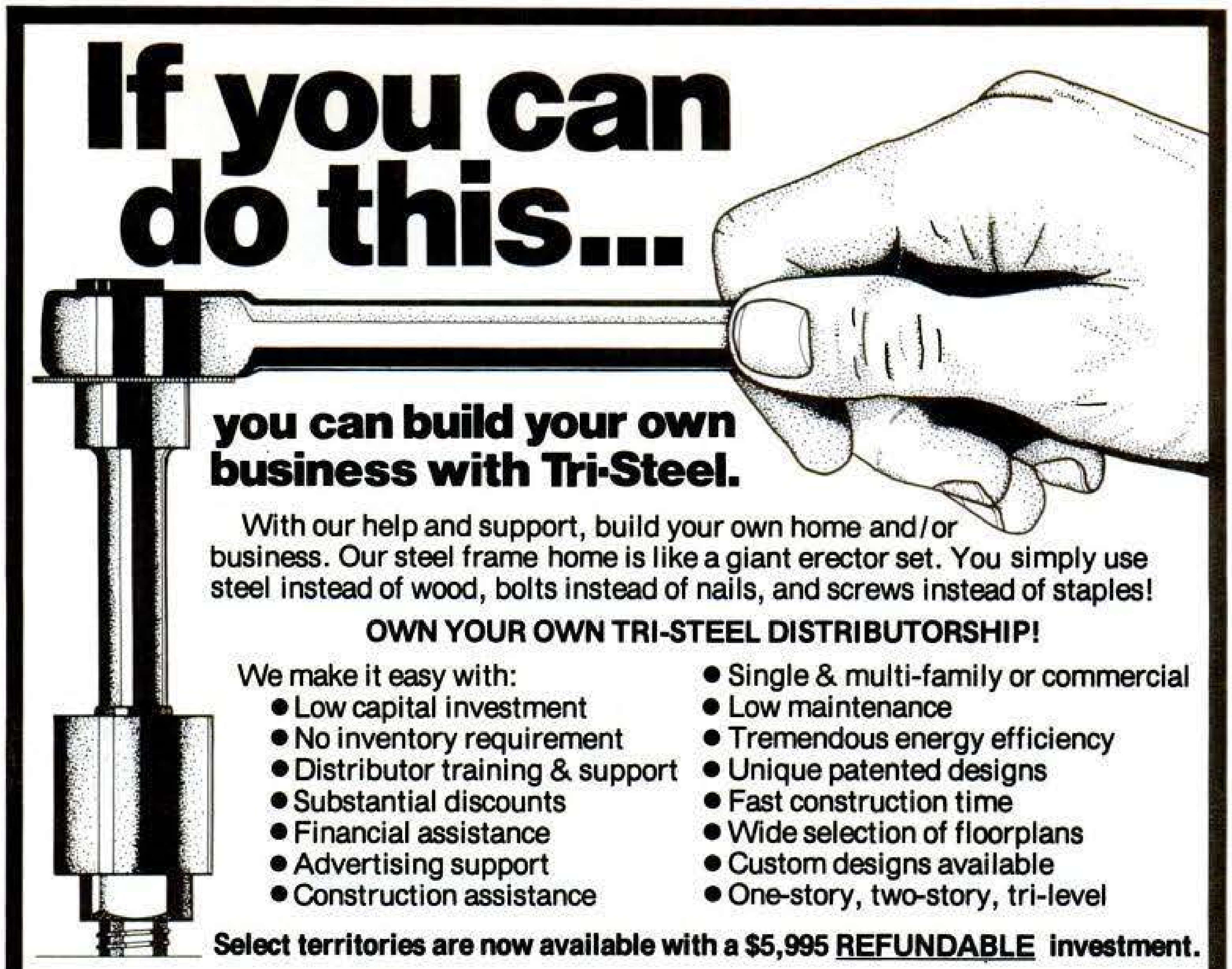
STIHL®
The World's Largest Selling Chain Saw.

1926–1986 60 STIHL®

For sales and service, see the Yellow Pages under "saws" or call toll-free 1-800-528-6050.

Write for free saw or trimmer safety manual Stihl, Inc. 536 Viking Dr., Virginia Beach, VA 23452

© Stihl, Incorporated 1986 (670-035)



If you can do this...

you can build your own business with Tri-Steel.

With our help and support, build your own home and/or business. Our steel frame home is like a giant erector set. You simply use steel instead of wood, bolts instead of nails, and screws instead of staples!

OWN YOUR OWN TRI-STEEL DISTRIBUTORSHIP!

We make it easy with:
- Low capital investment
- No inventory requirement
- Distributor training & support
- Substantial discounts
- Financial assistance
- Advertising support
- Construction assistance
- Single & multi-family or commercial
- Low maintenance
- Tremendous energy efficiency
- Unique patented designs
- Fast construction time
- Wide selection of floorplans
- Custom designs available
- One-story, two-story, tri-level

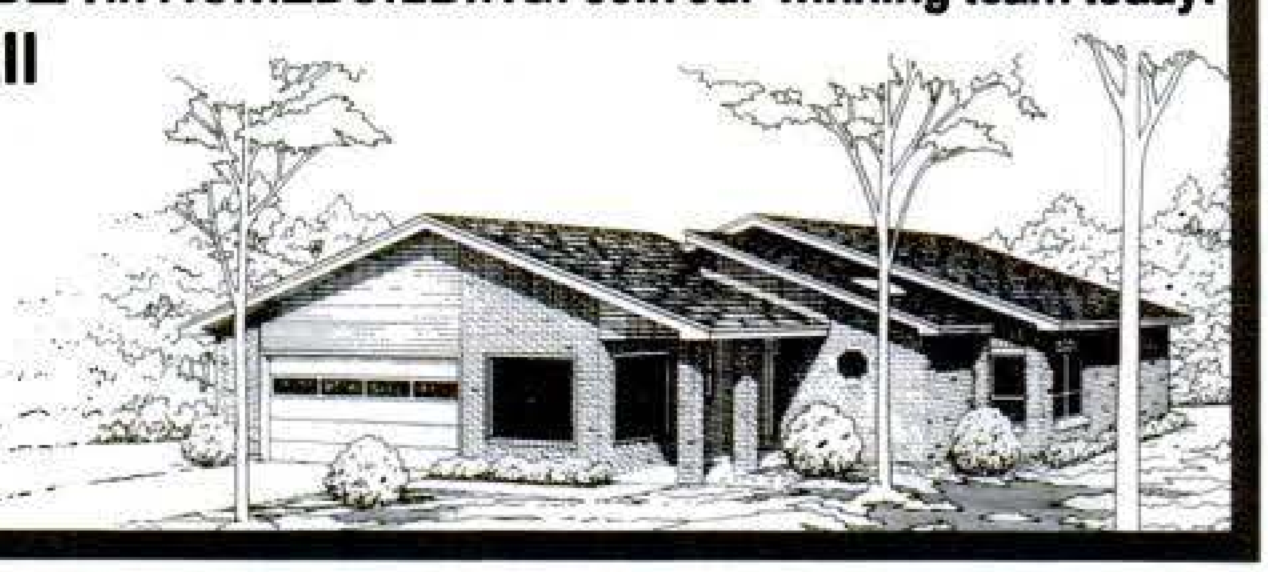
Select territories are now available with a $5,995 REFUNDABLE investment.

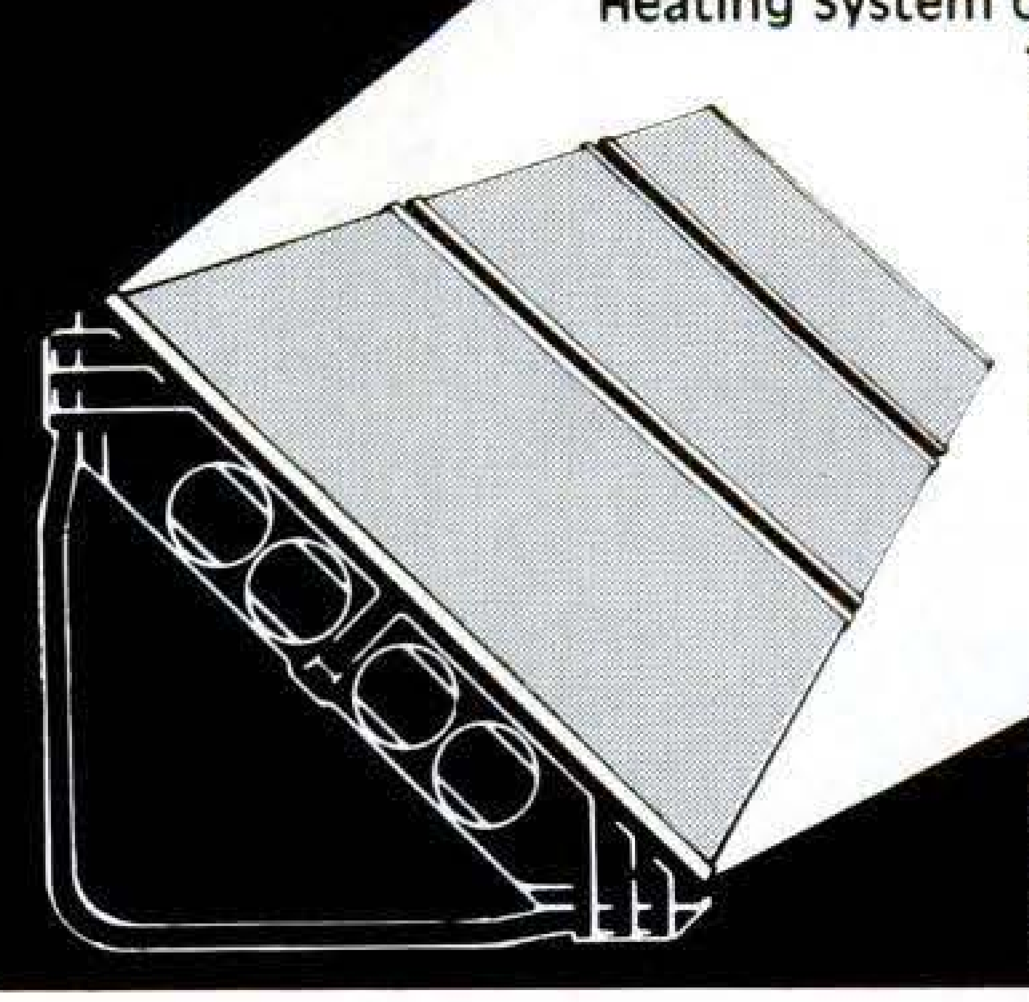
Take advantage of the HOTTEST IDEA in HOMEBUILDING! Join our winning team today.

For more information call
toll free (800)433-5555
[in TX, (800)772-5909]

Tri-Steel Structures
Denton, Texas

© 1986 All Rights Reserved





When oil prices go back up, the sun will still be free.

Act now and avoid the rush.

Find out how easily the Hansolar TA-3 Solar Space Heating System can lower your bills and keep them that way. Just send us $1, and we'll send you our complete *solar information kit and siting test.*

- **cost efficient**
- **maintenance-free**
- **simple to install**
- **modular design**

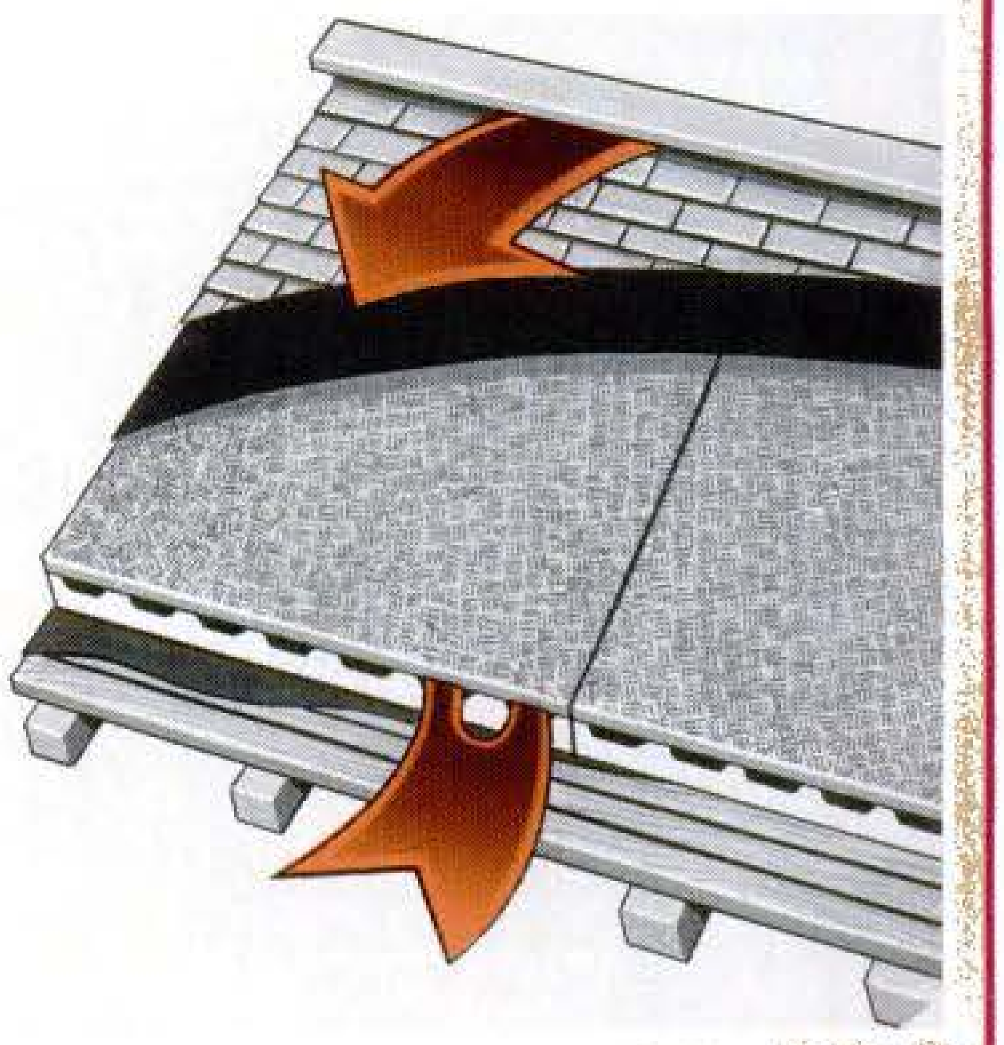
Hanson Energy Products, Inc.
P.O. Box 287A
Newcastle, Maine 04553
207/563-3884

Name ______________________ Phone __________
Address ______________________________
City ________________ State ________ Zip __________

New products

HOME ENERGY

Do-all ceiling panels



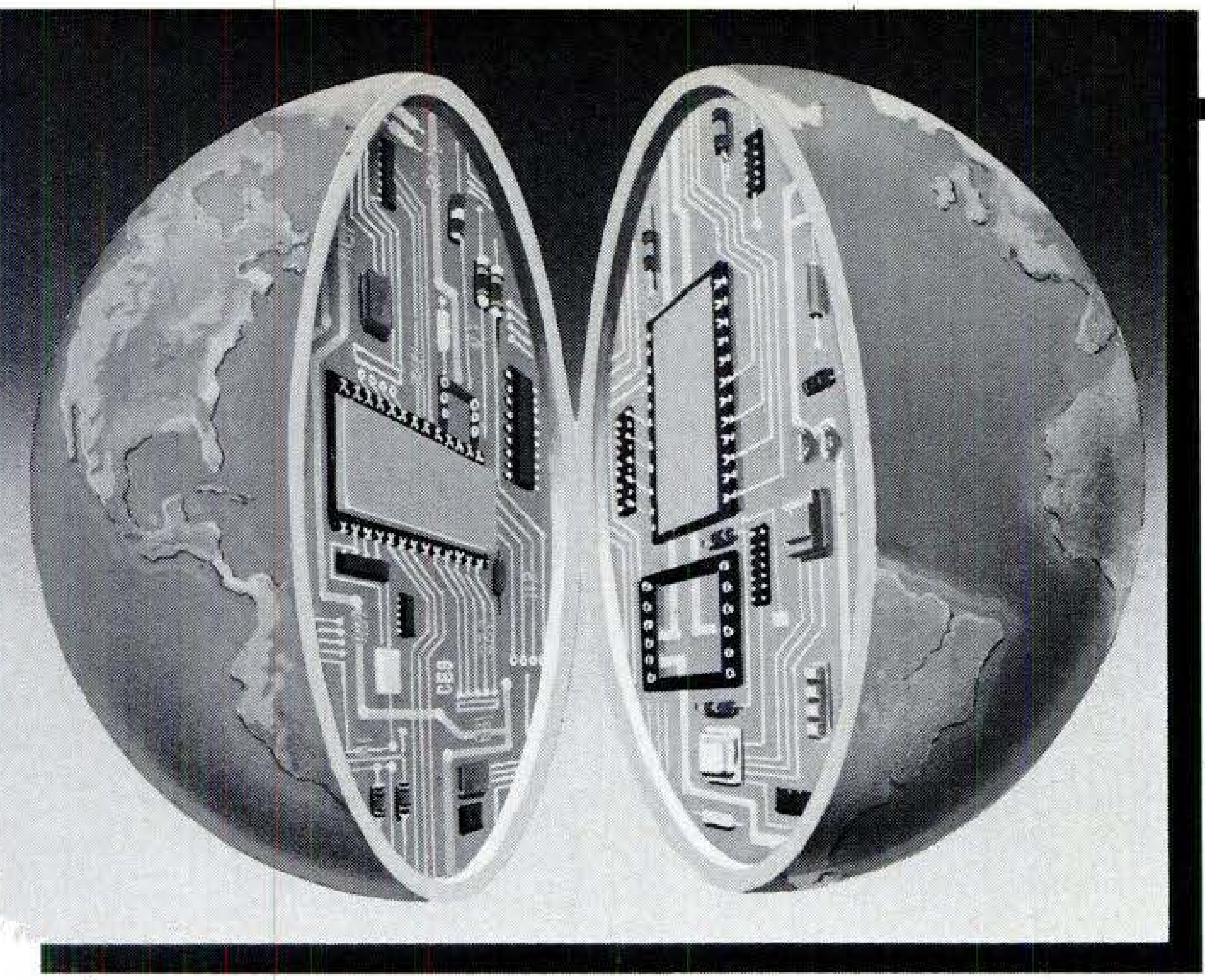
Insulating and ventilating a cathedral ceiling is a one-step process with Air-Flo panels. The standard panel is a composite of ½-in. oriented strand board with a layer of grooved expanded polystyrene (EPS) laminated below (see drawing). Placed over the framework of a cathedral ceiling, these panels impart insulating values ranging from R-16 to R-40.

There are two other panel models, one with a gypsum interior skin and the other with strand board on both sides; the panel can span 6–8-ft. distances between rafters.

Air flows in soffit vents, through grooves in the EPS, and out the ridge vent. This constant ventilation helps keep the roof and house interior cool in summer. In winter, the ventilation prevents ice dams by keeping the roof a uniform temperature. Branch River Foam Plastics, 15 Thurber Blvd., Smithfield, R.I. 02917.

Cement housecoat

Insulating with cement may sound cumbersome. But Air Krete, a fireproof cementitious insulation, is foamed in between studs or into the cores of concrete blocks and weighs only 2 lbs./cu. ft. The insulation sets in 6–10 sec., cures in two weeks, and is perfect for retrofits, says Air Krete (Box 380, Weedsport, N.Y. 13166). Its R-value (4 per sq. in.) is similar to that of urea formaldehyde insulation, but Air Krete is 98% inorganic and produces no fumes. It costs $1.25 to $1.50 per sq. ft.—*Naomi Freundlich*



CIE MAKES THE WORLD OF ELECTRONICS YOURS.

Today's world is the world of electronics. But to be a part of it, you need the right kind of training, the kind you get from CIE, the kind that can take you to a fast growing career in business, medicine, science, government, aerospace, communications, and more.

Specialized training.

You learn best from a specialist, and that's CIE. We're the leader in teaching electronics through independent study, we teach only electronics and we've been doing it for over 50 years. You can put that experience to work for you just like more than 25,000 CIE students are currently doing all around the world.

Practical training.

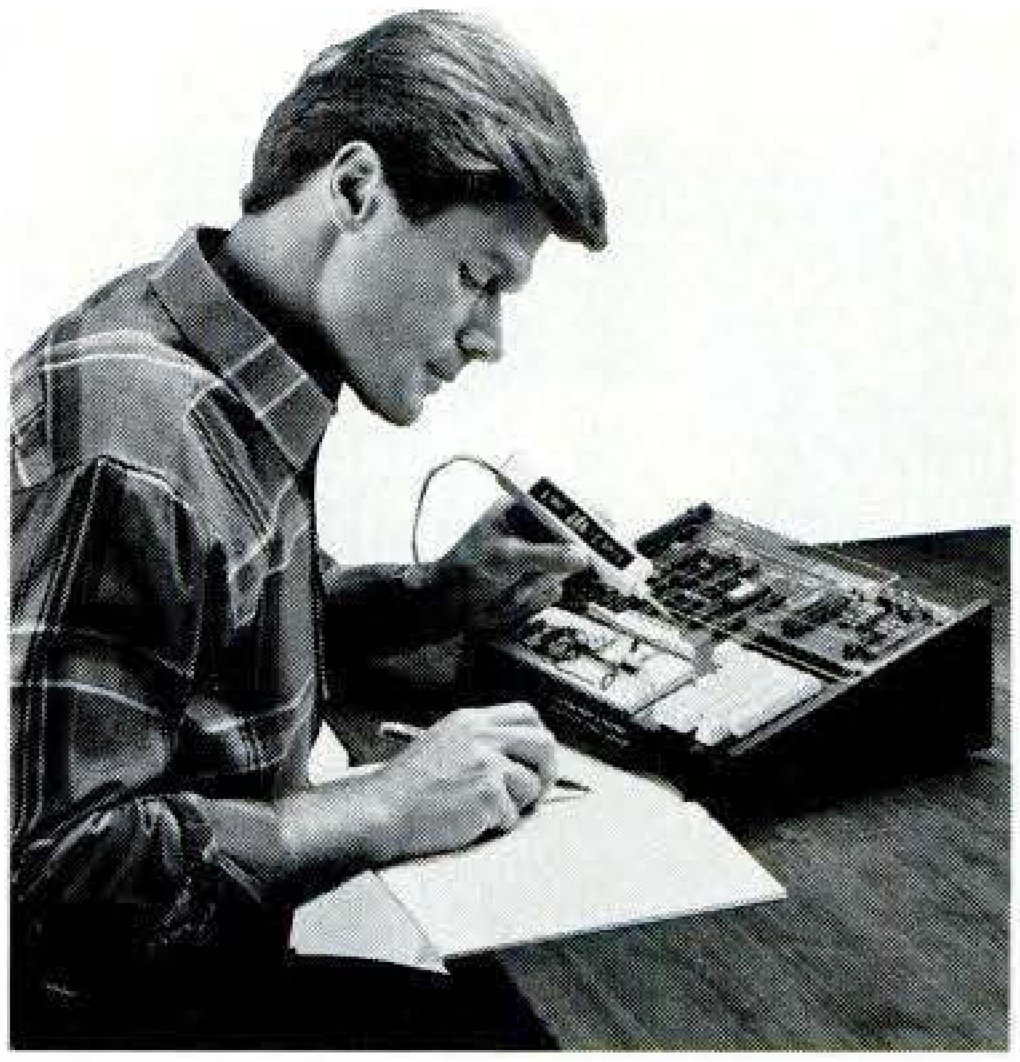
You learn best with practical training, so CIE's Auto-Programmed® lessons are designed to take you step-by-step, principle-by-principle. You also get valuable hands-on experience at every stage with sophisticated electronics tools CIE-designed for teaching. Our 4K RAM Microprocessor Training Laboratory, for example, trains you to work with a broad range of computers in a way that working with a single, stock computer simply can't.

Personalized training.

You learn best with flexible training, so we let you choose from a broad range of courses. You start with what you know, a little or a lot, and you go wherever you want, as far as you want. With CIE, you can even earn your Associate in Applied Science Degree in Electronics Engineering Technology. Of course, you set your own pace, and, if you ever have questions or problems, our instructors are only a toll-free phone call away.

The first step is yours.

To find out more, mail in the coupon below. Or, if you prefer, call toll-free **1-800-321-2155 (in Ohio, 1-800-523-9109).** We'll send you a copy of CIE's school catalog and a complete package of enrollment information. For your convenience, we'll try to have a representative contact you to answer your questions.



PS09

CIE Cleveland Institute of Electronics
1776 East 17th St., Cleveland, Ohio 44114

YES! I want to get started. Send me my CIE school catalog including details about the Associate Degree Program. I am most interested in:

☐ computer repair
☐ telecommunications
☐ robotics/automation
☐ television/high fidelity service
☐ medical electronics
☐ broadcast engineering
☐ other____________________

Print Name ______________________________

Address ____________________ Apt. __________

City _______________ State __________ Zip ________

Age ______ Area Code/Phone No. ____________________

Check box for G.I. Bulletin on Educational Benefits
☐ Veteran ☐ Active Duty

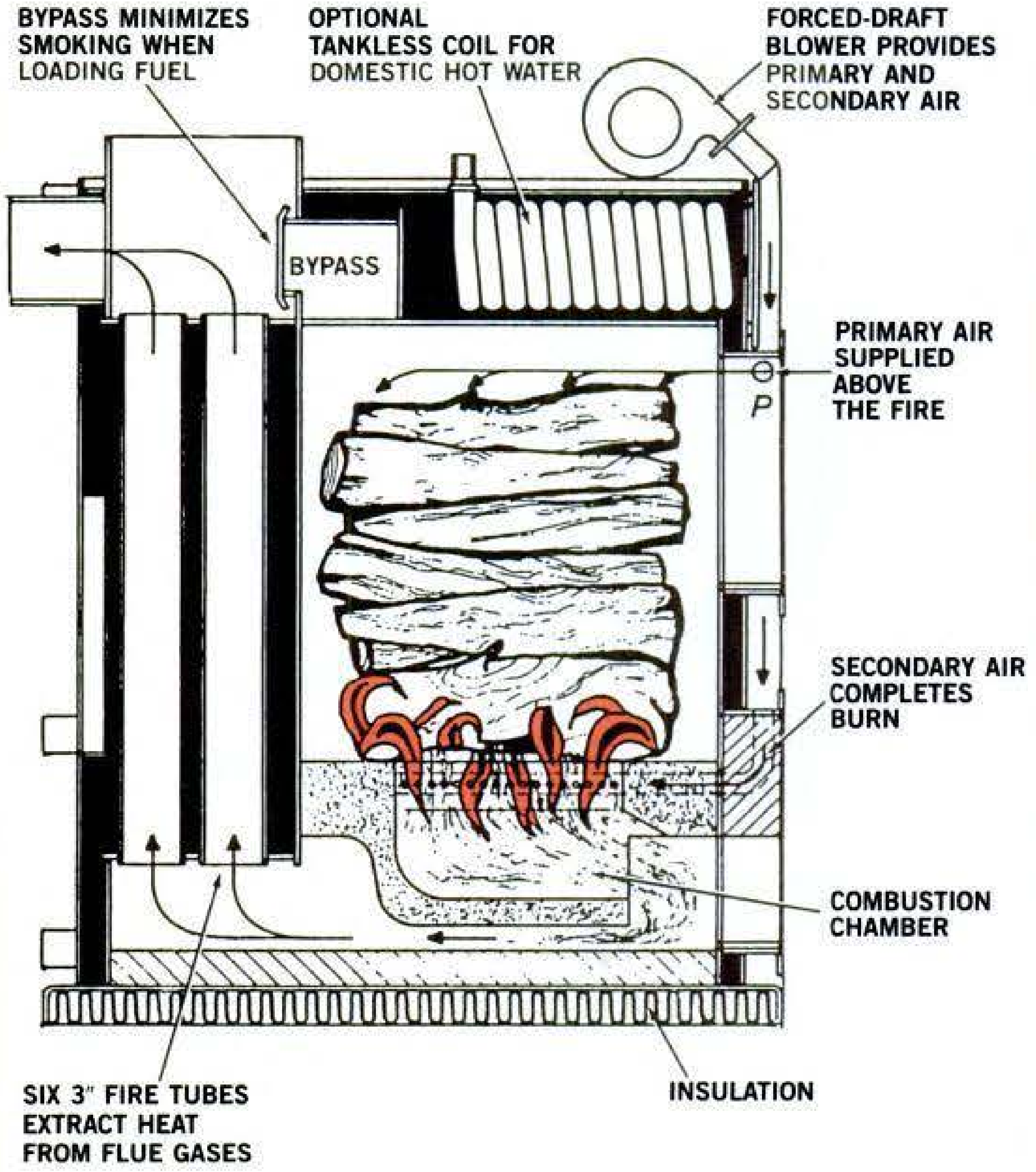
MAIL TODAY!

OR CALL TOLL FREE 1-800-321-2155 (In Ohio, 1-800-523-9109)

New products

HOME ENERGY

No-bother wood boiler


BYPASS MINIMIZES SMOKING WHEN LOADING FUEL
OPTIONAL TANKLESS COIL FOR DOMESTIC HOT WATER
FORCED-DRAFT BLOWER PROVIDES PRIMARY AND SECONDARY AIR
BYPASS
PRIMARY AIR SUPPLIED ABOVE THE FIRE
P
SECONDARY AIR COMPLETES BURN
COMBUSTION CHAMBER
INSULATION
SIX 3" FIRE TUBES EXTRACT HEAT FROM FLUE GASES

A thermostat controls the heat output of this new wood-burning boiler. After it's filled with wood and the fire's started, the HS Tarm 2000 cycles on and off as needed, just like an oil or gas burner. Developed in Denmark, it's marketed here by Tekton Corp. (Conway, Mass. 01341).

Here's how it works: When the thermostat calls for heat, the 40-W blower (see drawing) comes on, supplying oxygen to the fire. When the thermostat is satisfied, the blower turns off and the fire dies down. But the combustion chamber remains hot enough to reignite the wood when the thermostat again calls for heat.

The $3,500 HS Tarm 2000's high combustion efficiency (80% to 85%) is achieved without a catalytic combustor [PS, Jan. '82]. The temperature in the flame tunnel below the combustion chamber can climb as high as 2,000° F. At that temperature, the gases from the burning wood ignite, providing heat to your house—instead of smoke up the chimney.

Heat output ranges from 17,000 to 102,450 Btu/h, plenty for a 2,500-sq.-ft. house, says Tekton. You need to feed the fire every 4 to 26 hrs.—*Jennifer Lynch*

ONE
TWO
SAFE-T-FLUE

Burning wood produces creosote deposits...the number one cause of chimney fires.

Knock-out Creosote Build-up with the Ol' One - Two.

Liquid Safe-T-Flue and Chimney Brushes from Worcester Brush–the Winning Combination.

Regular use of Liquid Safe-T-Flue in your stove or fireplace transforms creosote into a fine, powdery ash. Liquid Safe-T-Flue is non-polluting, non-flammable, non-corrosive and it's easy to use.

Combining the regular use of Liquid Safe-T-Flue with timely brushing with a Worcester chimney brush is the sure-fire way to virtually eliminate chimney fires and increase burning efficiency, giving you more heat for less fuel.

Look for these and other fine products from Worcester Brush at your local stove shops, home centers or hardware stores.

LIQUID SAFE-T-FLUE CHIMNEY CLEANER
$1.00 CASH REBATE

Get a $1.00 rebate when you buy Liquid Safe-T-Flue between September 1 and November 30, 1986.

WORCESTER BRUSH™
P.O. Box 658 Worcester, MA 01601
617-754-6811

New products

HOME ENERGY

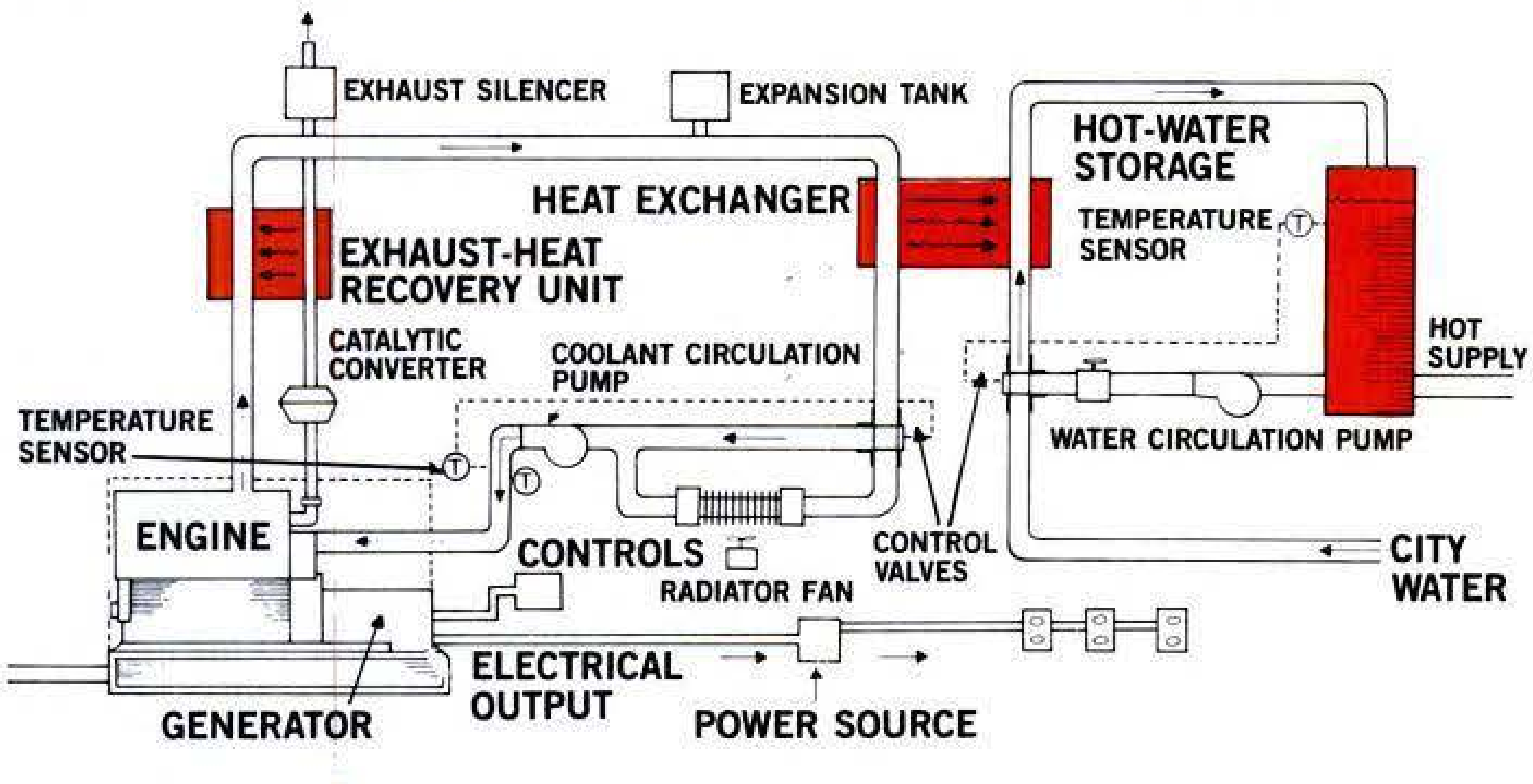
Window dressing

Covering windows with plastic film can help keep your house warm in winter. But the look? Well, surely it doesn't complement that Louis XIV armchair. What's the solution? With a kit from 3M, you wrap the *outside* of your windows in a sheet of insulating film.

The clear film is attached with a new high-performance tape that sticks to your window trim. The double-coated tape won't lose its grip in rain, wind, or severe cold, 3M says, yet it peels off easily at the end of the cold season. You don't need tacks or staples, so you don't create holes through which air can escape. The covering increases insulation value by 86% for an average single-pane window, claims 3M.

The new kits come in three sizes. It costs $3 to $4 to cover a standard window.—*D. S.*

Baby cogenerators


EXHAUST SILENCER
EXPANSION TANK
HOT-WATER STORAGE
HEAT EXCHANGER
EXHAUST-HEAT RECOVERY UNIT
TEMPERATURE SENSOR
CATALYTIC CONVERTER
COOLANT CIRCULATION PUMP
HOT SUPPLY
TEMPERATURE SENSOR
WATER CIRCULATION PUMP
ENGINE
CONTROLS
CONTROL VALVES
CITY WATER
RADIATOR FAN
ELECTRICAL OUTPUT
GENERATOR
POWER SOURCE

With a machine no bigger than a refrigerator, you can have your own private utility, providing all the heat, hot water, and electricity your home needs. These new cogeneration units run on natural gas, propane, or diesel fuel, and convert up to 80% of the fuel into heat and electricity.

There are two "baby cogens" on the market, a 10.5-kW unit from Thermex (1086 N. Kraemer Pl., Anaheim, Calif. 92806) and 6.5- and 7.5-kW units made by Van Weld Inc. (Box 26885, Albuquerque, N.M. 87125).

Thermex's unit, the 10.5-kW Powerstation, is an induction unit: It must be hooked into the power grid, which provides the excitation current for the generator. When the power fails, so does the cogeneration unit.

Van Weld's cogenerators are synchronous units (see drawing). They supply their own excitation and thus can run independently of the utilities, even during power outages.

With an induction cogenerator, it's technically easy to sell any surplus electricity back to the utility. But because cogenerator users have to pay hookup charges and rate penalties—and buy expensive safety equipment—you can't expect to make much profit that way.

Powerstation is priced at $9,800; the two Van Weld models cost $7,500 and $8,500. Powerstation produces 78,000 Btu/h of heat (3,000 gal. of hot water per day). Van Weld's 6.5-kW system has a heat output of 54,000 Btu/h.—*N. F.*

Geodesic Home Kits.

Beautiful, Efficient, Affordable.

Monterey Domes sells home kits for less than many new home down payments. Completely affordable...remarkably beautiful...our homes are designed for a lifetime of savings.

The most energy efficient homes on earth...up to 50% more than everyday homes. In addition, construction costs are cut dramatically using our patented building system...(our 1813 sq. ft. house package is just $15,660!)

Discover Monterey Domes living with our 100 page Color Catalog and Plans Book. ORDER TODAY for just $6.00. Unconditionally Guaranteed or your Money Back!

☐ **Please rush my 100 page copy of Monterey Domes *Catalog and Plans Book*. Enclosed is $6.00.**

☐ **Also please send me the Monterey Domes *Basic Dome Assembly Manual* for an additional $5.00.**

Order by Credit Card. Call 800-634-2255 (In Calif. 800-847-4663)

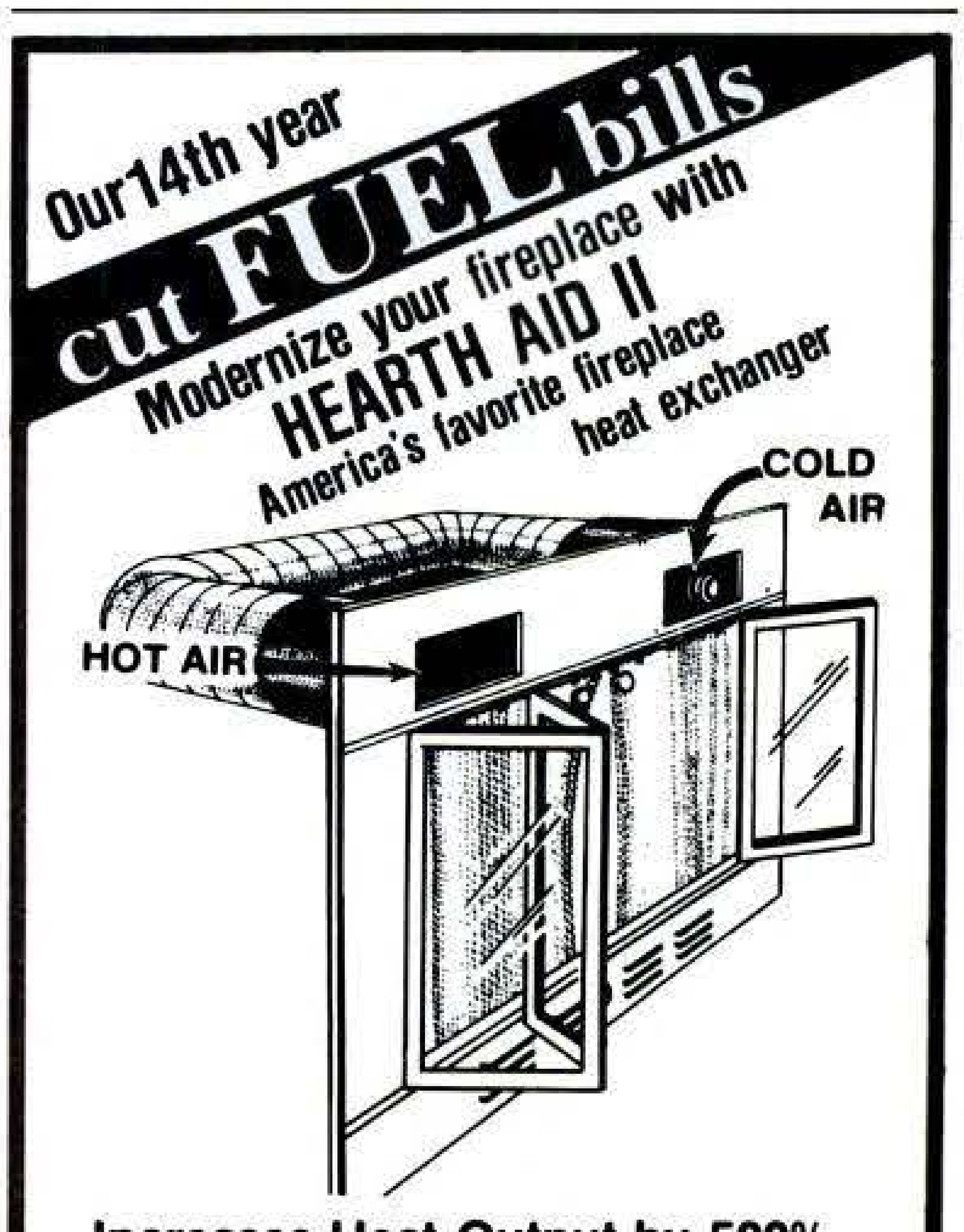
Name ______

Address ______

City/State/Zip ______

Send to: MONTEREY DOMES
Dept. AR-10
1760 Chicago Ave.
Riverside, Calif. 92517

MONTEREY DOMES.


Our 14th year
cut FUEL bills
Modernize your fireplace with
HEARTH AID II
America's favorite fireplace heat exchanger
COLD AIR
HOT AIR

Increases Heat Output by 500%

- *Custom Fit to any Fireplace.
- *Easy to install.
- *Thermostatically controlled, works automatically.
- *Super Efficient titanium stainless Heat Exchanger. No extras to buy
- *No dangerous Creosote Buildup

And best of all you can enjoy your fireplace while saving on your heating bills because with Hearth-Aid II ® you don't need to sacrifice your fireplace's appearance or the delight of an open fire to be energy efficient.

Works with: Wood, coal, or gas logs.

For Free Information, Write or Call:

**Thermalite Dept PS, 1124 Harpeth Industrial Ct.
Franklin, TN 37064
Nationwide Toll Free: 1-800-742-HEAT
TN Only: 615-794-8425**

We specialize in arches, corners & prefabs.

IF YOU'RE REPLACING WINDOWS, FORGET ABOUT FITTING SYSTEMS, FIT KITS, TRIM STRIPS, INSTALLATION CLIPS, EXTENDERS, FILLERS AND ALL THE OTHER NONSENSE.

MARVIN PRESENTS THE BEST INSTALLATION AID OF ALL...

FREE.

Replacing a window is easy, if you start with the right window.

This free 16-page booklet will tell you what to look for in a window, even how to install it. And the free catalog we'll send you along with it can help you choose the Marvin Windows that are right for you.

If you're remodeling or replacing windows, this booklet is made to order for you. Just like Marvin Windows.

For your free copy, send us the coupon or call this toll-free number:

1-800-346-5128
In Minnesota, call 1-800-552-1167

Send to: Marvin Windows, Warroad, MN 56763

Name______________________________

Address____________________________

City__________________ State________

Zip________________

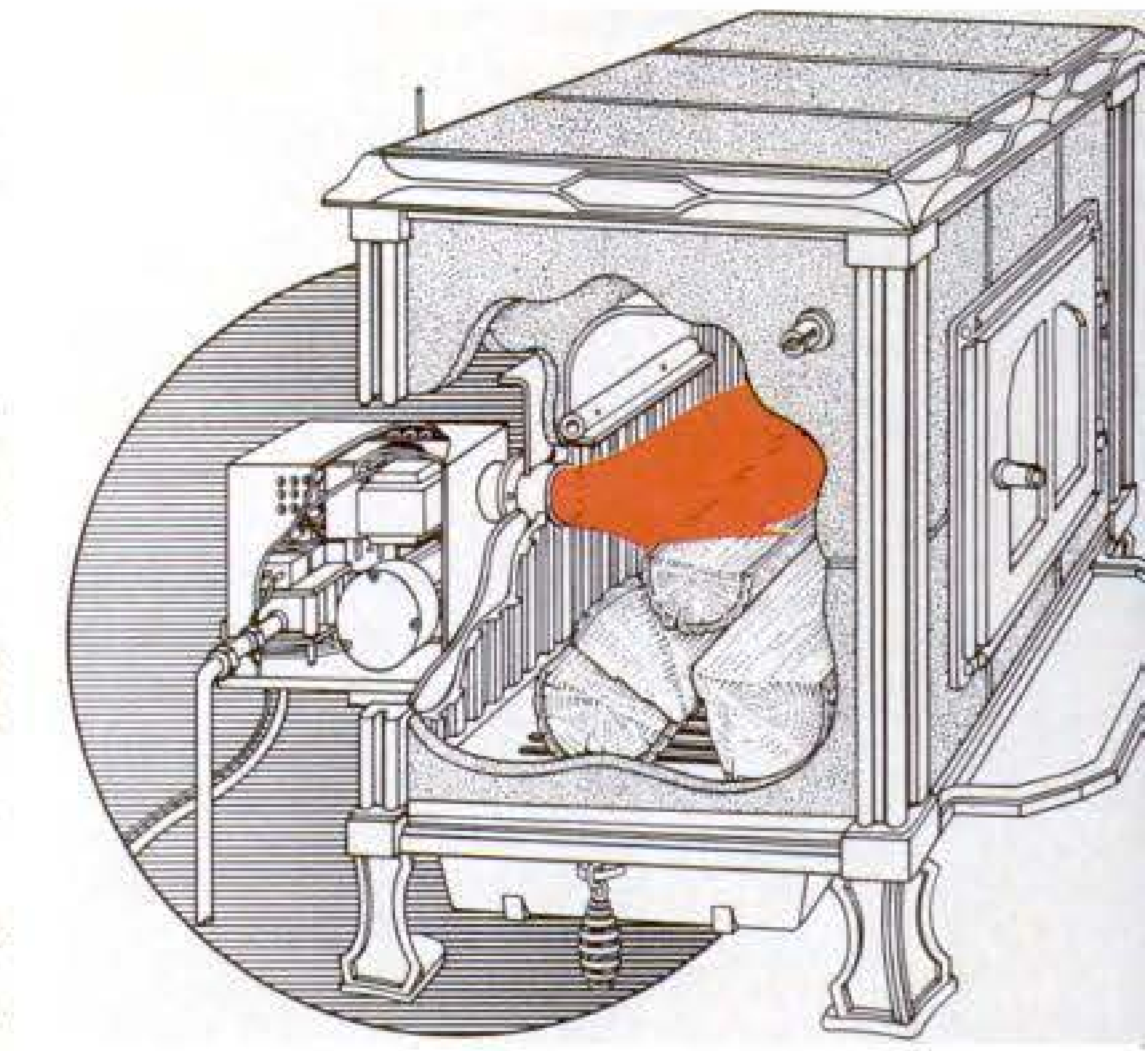
PS-0084-10

MARVIN WINDOWS ARE MADE TO ORDER.

New products

HOME ENERGY

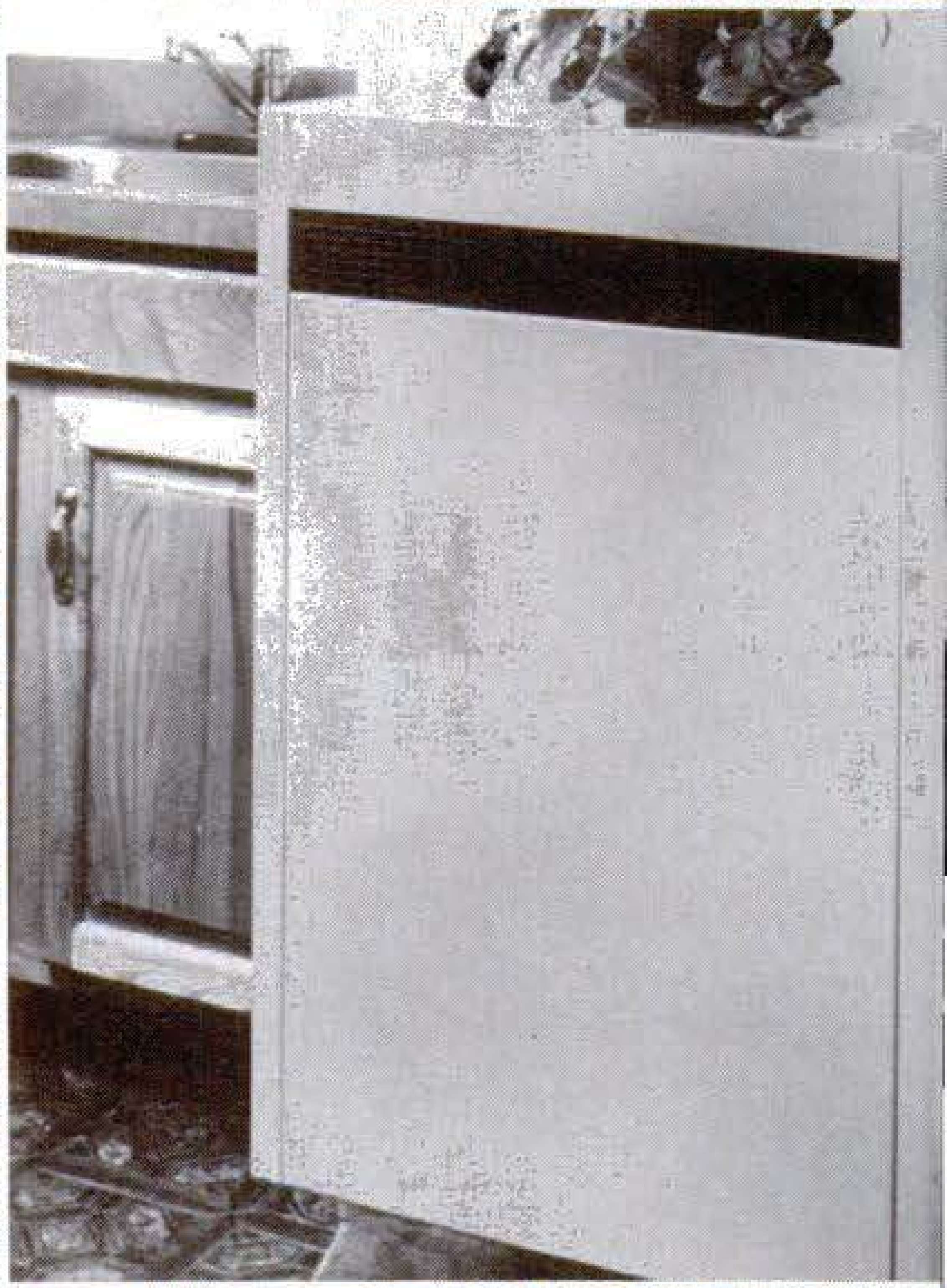
Dual-fuel wood stove



Wood-stove owners can now enjoy the security and comfort of a backup heating system—without installing one. HearthStone's new Gemini System ($1,600) burns gas when there is no wood in the stove. A thermostatically controlled gas burner attached to the back of the stove automatically activates when the stove cools. When there is wood in the stove, the burner's silicon-carbide heating element ignites it—no need for matches or kindling.

The gas burner has a 49,000 Btu/h output; 44,000 Btu/h for the wood stove, says HearthStone (Morrisville, Vt.).—*Jennifer Lynch*

Hang-on-the-wall boilers



Two wall-mounted gas boilers offer high-efficiency heating in a compact package. Meant for small houses and apartments, they give condominium dwellers the advantage of independent control and monitoring rather than sharing a central heating plant.

The boiler shown is the AHE from Weil-McLain (Blaine St., Michigan City, Ind. 46360). It comes in two sizes, 45,000 Btu/h and 60,000 Btu/h. The units are cast iron and operate at an energy-saving 85% annual fuel utilization efficiency (AFUE). Installed cost is from $1,800 to $2,200, depending on the job.

Another new boiler is made by Burnham Corp. (2 Main St., Irvington, N.Y. 10533). Burnham's XG1000 series cast-iron gas boilers come in three sizes: 35,000 Btu/h (84.3% AFUE, $1,172); 70,000 Btu/h (82.5% AFUE, $1,272); and 105,000 Btu/h (80% AFUE, $1,434). Burnham's boilers use outside air in a sealed-combustion system.—*Michael Neubarth*

Toxic telltale

Nausea, dizziness, irritability. Sound like the flu? Well, it may not be, and a mis-diagnosis could kill you.

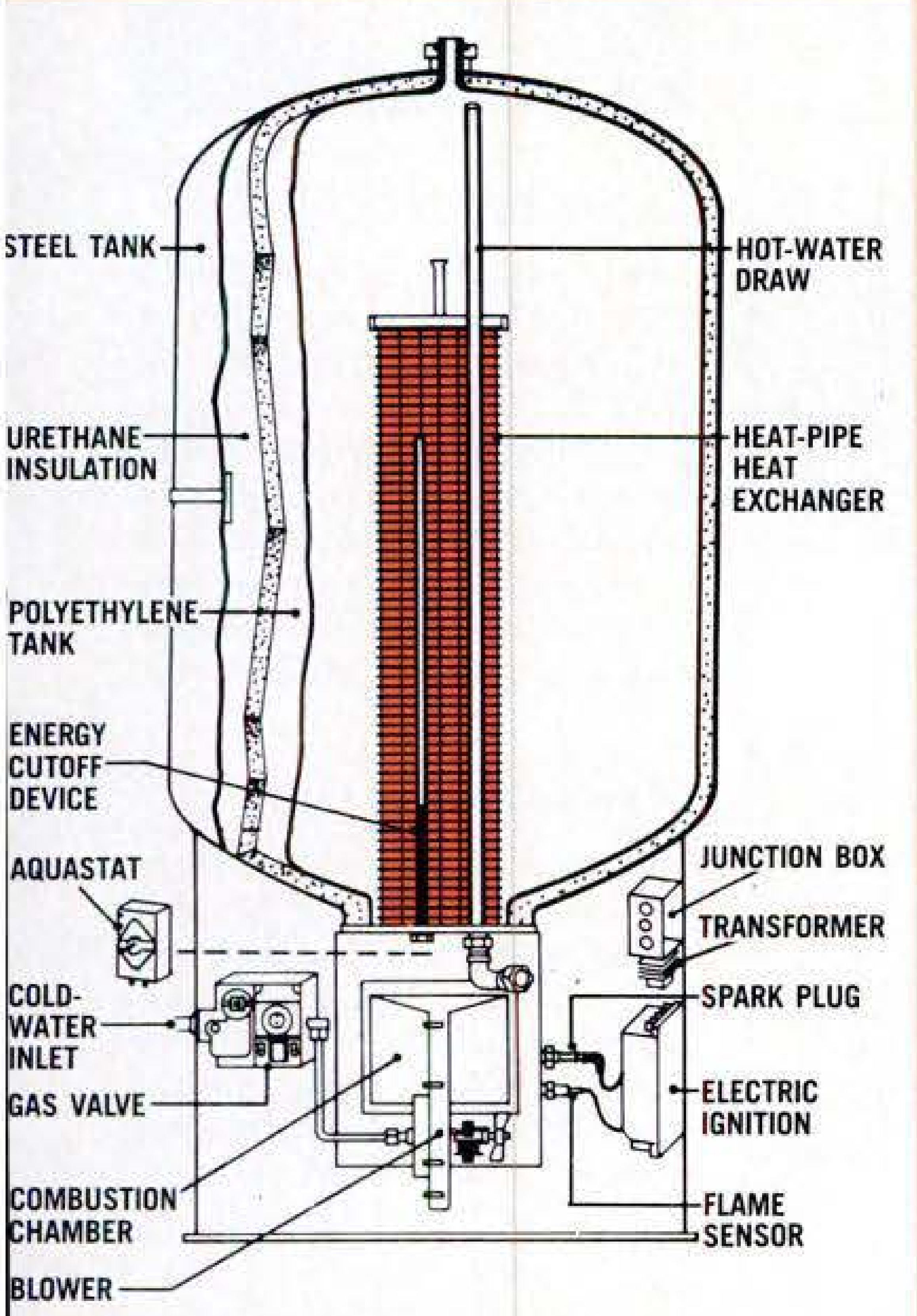
Carbon monoxide is an invisible, odorless gas produced by cars, faltering furnaces, fireplaces, and wood-burning stoves. In high concentrations it causes flu-like symptoms.

The ToxAlarm detects harmful levels of carbon monoxide in the air. It consists of a cardboard mounting and a beige silica-gel tablet that will turn gray in the presence of as little as 50 parts per million carbon monoxide in the air, the maximum workday exposure allowed by federal law.

The tablets must be replaced each month. ToxAlarm (516 Ludlow Ave., Cincinnati, Ohio 45220); $10 for a 6-mo. supply.—*J. L.*

New products

HOME ENERGY

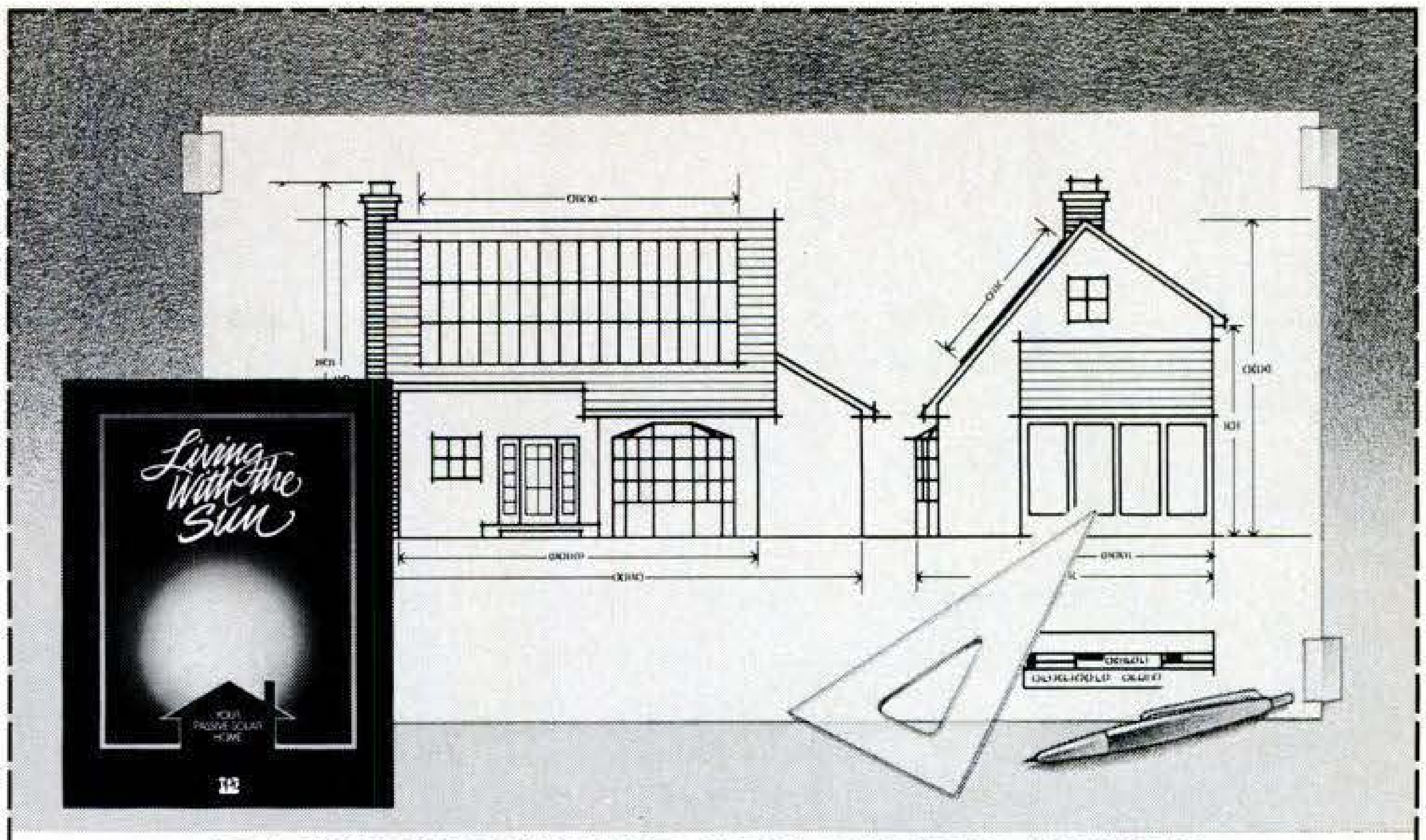


New-tech water heater

Heat pipes form the heat exchanger in this new gas water heater, Amtrol's Hot Water Maker. That's one reason it can boast an efficiency of 85%.

Inside a heat pipe, a working fluid vaporizes at the bottom and condenses at the top, thus transferring latent heat [PS, Feb. '84]. Here, heat is moved from the combustion chamber to the water in the tank. Specs: 40-gal. tank; power gas burner; 38,000 Btu/h input; installed cost: $750. Amtrol, 1400 Division Rd., W. Warwick, R.I. 02893.—*V. E. G.*

ToxAlarm
carbon monoxide indicator



BEFORE YOU BUILD, YOU SHOULD KNOW EVERY TRICK IN THE BOOK.

This book's on passive solar homes. Handsome, comfortable homes where many owners report savings on heating ranging from 40 to 80 percent, compared to traditional homes.

No matter where you live, find out how you can design your next home to use free energy from the sun. Send $1.00 to PPG Industries—America's leading glassmaker— for your 40-page, full-color copy of "Living with the Sun." Write: PPG Industries, Inc., Passive Solar Marketing, P.O. Box 8727, Harrisburg, PA 17105.

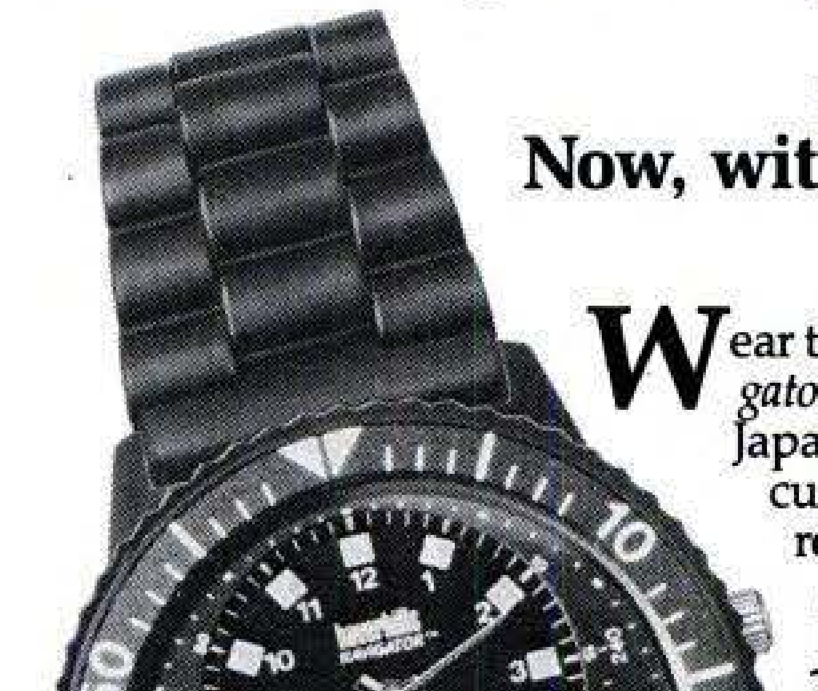
Name__________

Street__________

City__________ State______ Zip______

PC76

PPG



An outstanding watch value: on land, at sea, and underwater . . .

Navigator™ Watch

Now, with new ratcheted safety bezel, and still only $49.95*

***But read the ad for an even better deal!**

Wear this watch to work, to play, to swim and dive. The *Navigator™ Watch* is powered by a sophisticated, ultra-accurate Japanese quartz movement that is powered by a tiny mercury cell. It should last at least 18 months before you need replace it. The *Navigator™* has *both* luminous analog dial *and* LCD display. It gives you dual time capability. The LCD display shows time continuously — in 12-hr. or 24-hr. mode. Push the button and you display day and date. There is a subtle yet insistent alarm and a switchable hourly time signal. The stopwatch/chronograph reads to 1/100 secs. and has "interrupt" and "lap" modes. A light switch illuminates the display.

The *Navigator™ Watch* is totally executed in black metal, including the linked, stainless steel band. It is waterproof to 150 ft. The new, exclusive ratcheted safety bezel prevents you from staying underwater longer than you had planned. The crystal is "mineral glass"—it will never scratch.

We import these outstanding watches directly in large quantities and are able to offer them for just $49.95. National catalog houses offer the identical watch for $120 or more, and that's *without* the exclusive safety bezel. But here is an even better deal: ***Buy two for $99.90, and we'll send you a third one absolutely FREE, with our compliments.*** Take advantage of this outstanding offer while it is available.

•Many successful products are being "knocked off" to the detriment of consumers. The *Navigator™* is no exception. Beware of *similar looking* imitations. There is only one genuine *Navigator™ Watch!*

FOR FASTEST SERVICE, ORDER
TOLL FREE (800) 431-9003
24 hours a day, 7 days a week

Please give order **#1015B570.** If you prefer, mail check or card authorization and expiration date. We need daytime phone for all orders and issuing bank for charge orders. We cannot ship without this information. UPS/insurance: $5.95 for one *Navigator™ Watch*, $6.95 for three. Add sales tax for CA delivery. You have 30-day return and one year warranty.

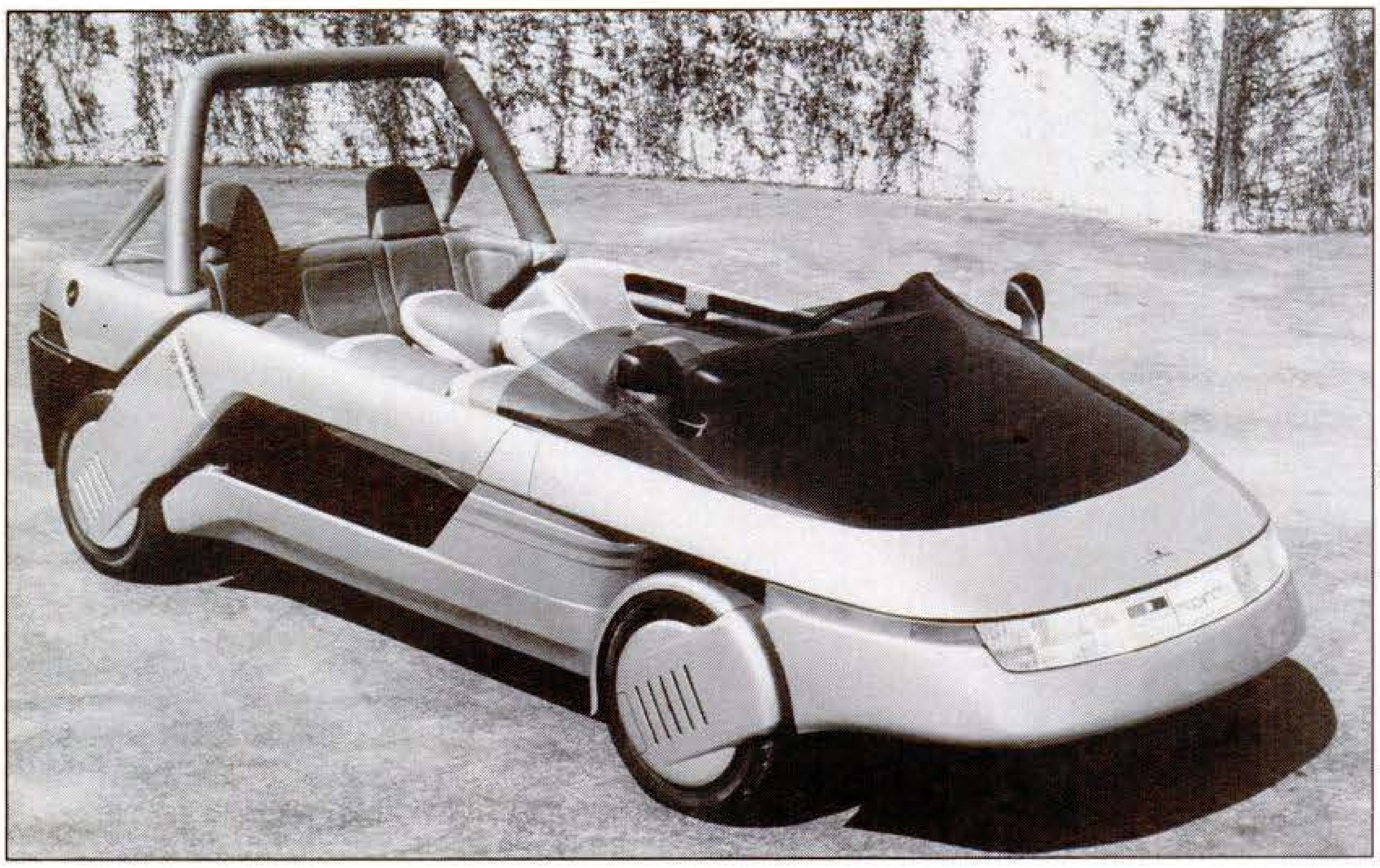
Note: For quantity orders (100+) with your company logo on the dial, call Mr. Gerard at (415) 543-6570 or write him at the address below.

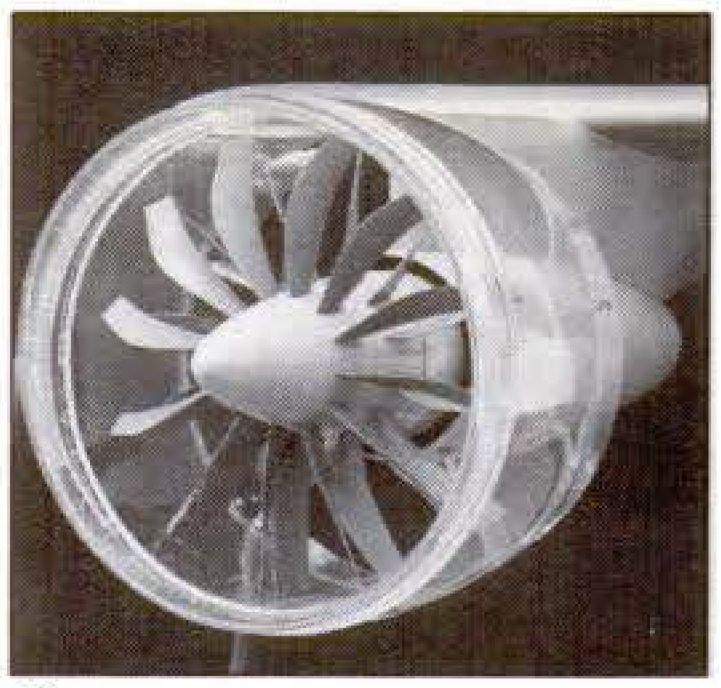
haverhills
since 1967
131 Townsend Street, San Francisco, CA 94107

What's New

products/technology

BY DAWN STOVER





Quieter propfan

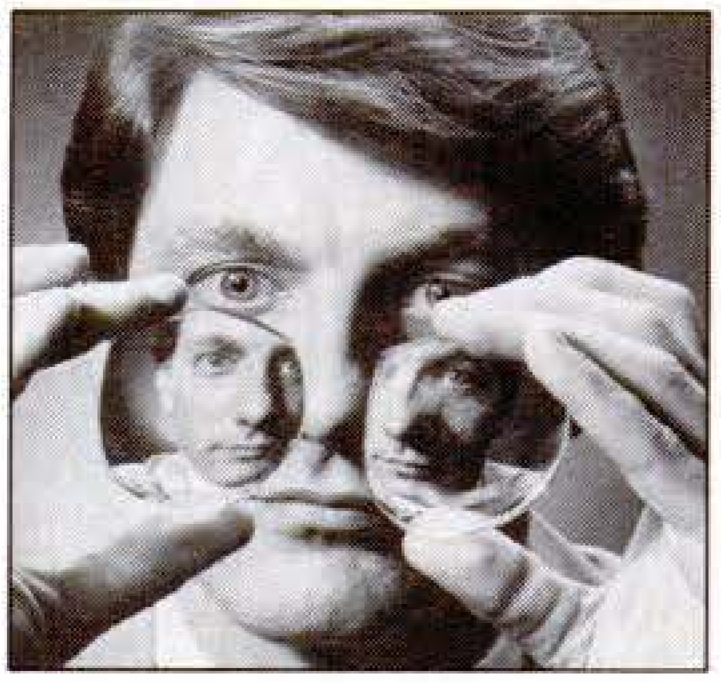
Propfans are more efficient than turbofans, but they're also noisy [PS cover, March '85]. MTU, a German company, says it solved the problem with its acoustically lined shrouded propfan. The engine fits under the wings of existing aircraft designs without major modifications.

Six-seater

Inspired by the dune buggies of the '70s, the Machimoto seats six. The vehicle has a 139-hp engine and two lines of buddy seats on a tubular frame. Side-impact bars lift up for saddle-seat access. Ital Design, Via A. Grandi 11, 10024 Moncalieri, Turin, Italy.

Resin lenses

Lens wearers with strong prescriptions can abandon their thick, heavy eyeglasses. PPG Industries now makes thinner, lighter lenses from high-refractive-index casting resin. The resin bends light more sharply and has a lower density than regular plastic or glass lenses, says PPG.

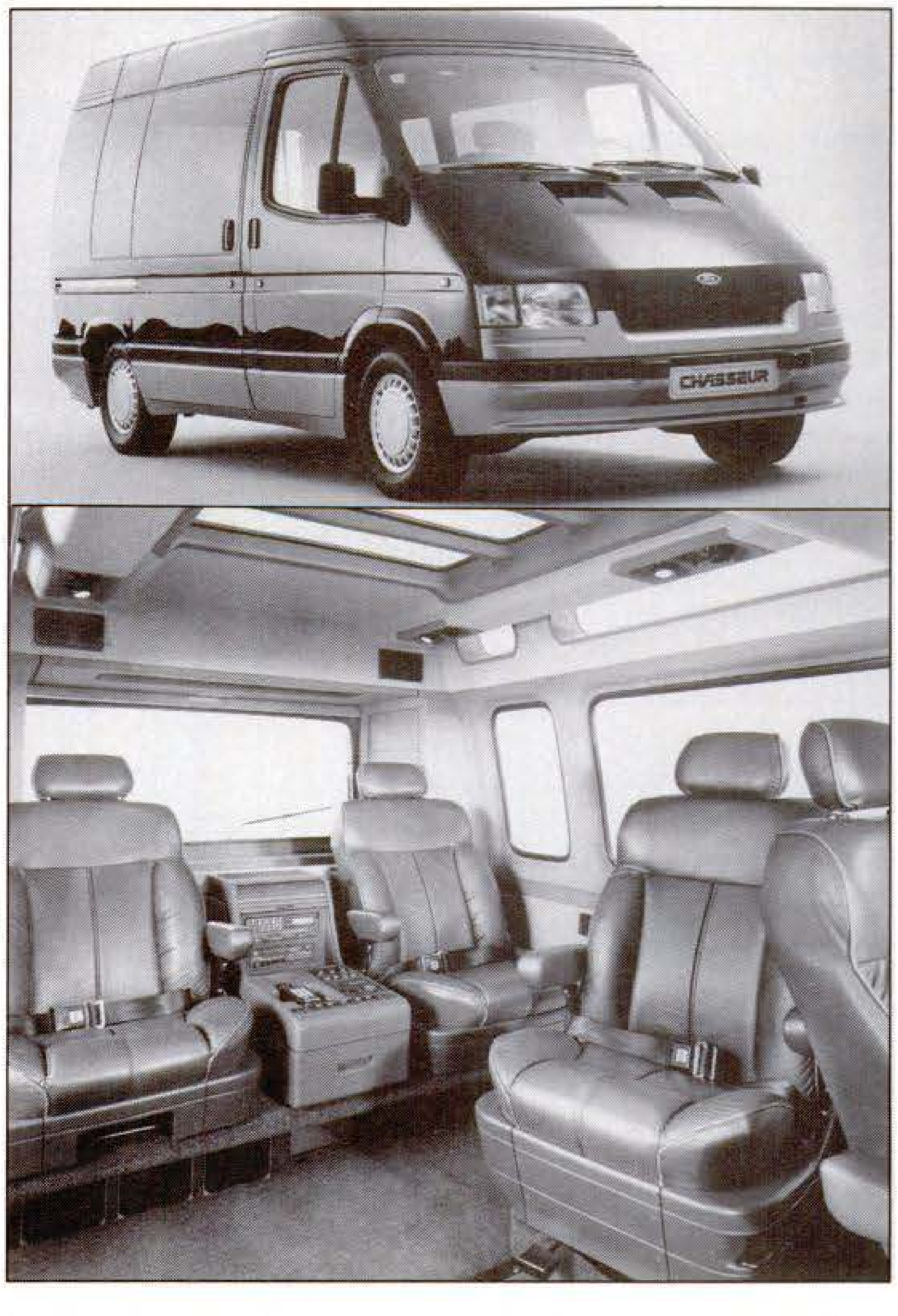


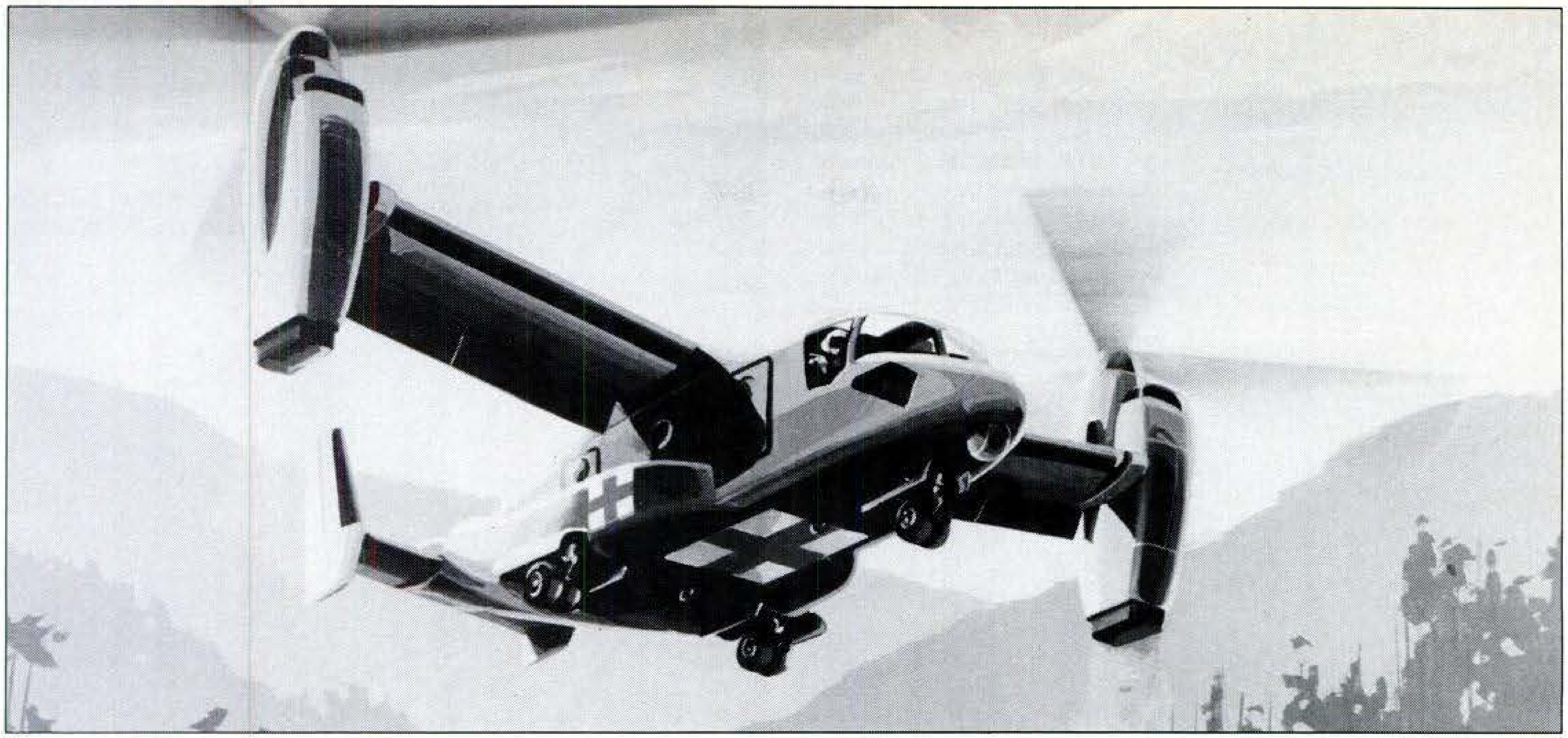
Plug-in vest

A switch cord attaches to Eclipse's $100 Electric Vest, and a fuse cord hooks directly to your motorcycle battery. The nylon oxford outer shell and Thinsulate insulation retain heat, which radiates throughout the vest. Eclipse, Inc., Box 3701, Ann Arbor, Mich. 48106.

Customized van

It starts as a Euroford Transit van and turns into a super-luxury Ford Chasseur. Each of the five leather-trimmed seats has its own cellular telephone, light and air controls, and earphones plugged into the video-audio system. Glass louvers in the high roof open electrically.



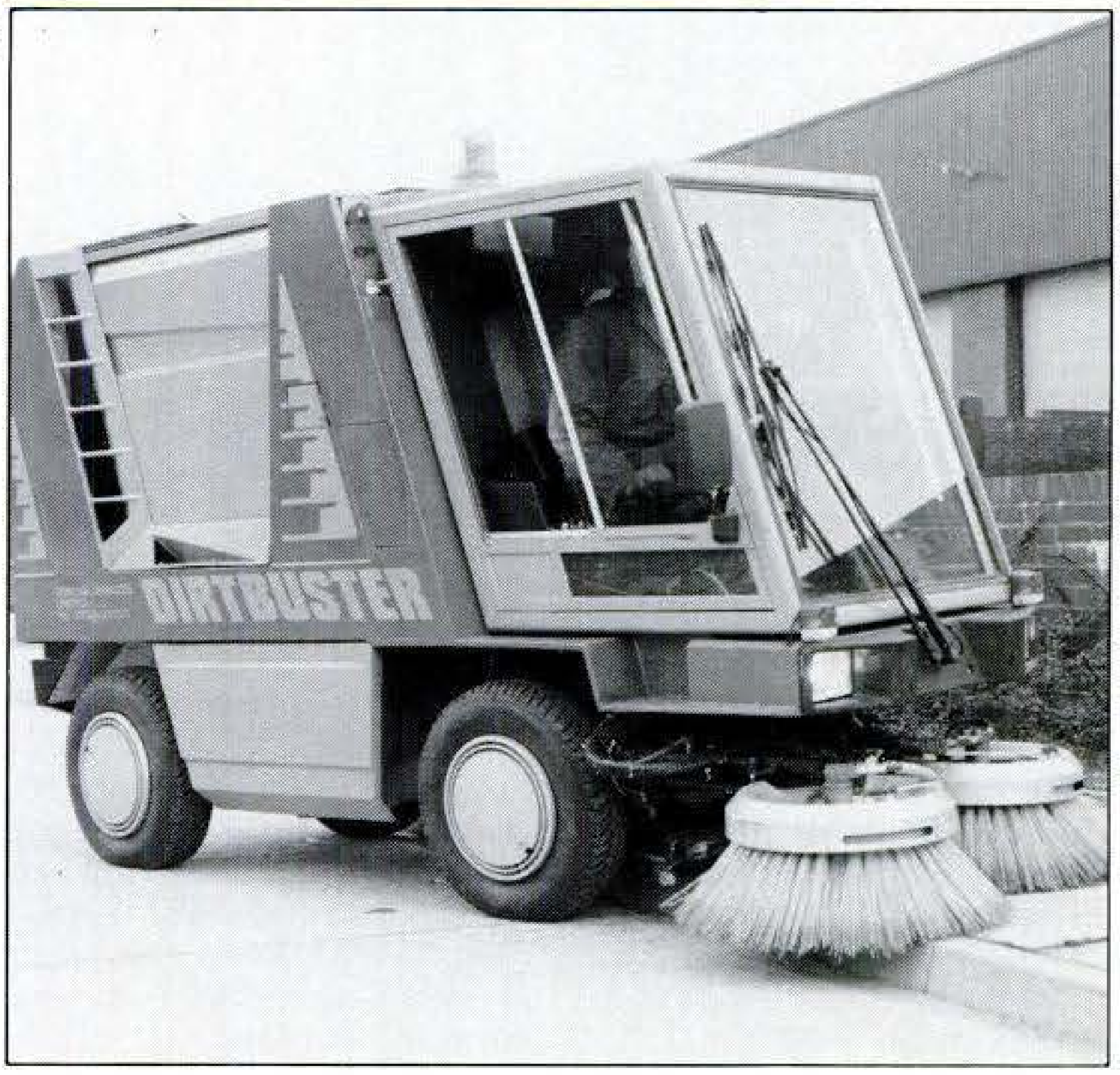


Two-way rotor

The V-22 Osprey, being developed by Bell Helicopter and Boeing Vertol, will take off and land like a helicopter. It will double most chopper speeds by tilting its rotors forward to act as propellers. The military wants more than 900 V-22s; deliveries start in 1995.

Clean sweep

Dirtbuster's brushes steer around a corner, spread to clear a 6.5-ft. path, or contract for easy passage of the 3.6-ft.-wide body. Made by Duncan Vehicles in England, the street sweeper mounts curbs easily. Lighter and faster than most units, it gulps up to 1.4 tons of dirt.

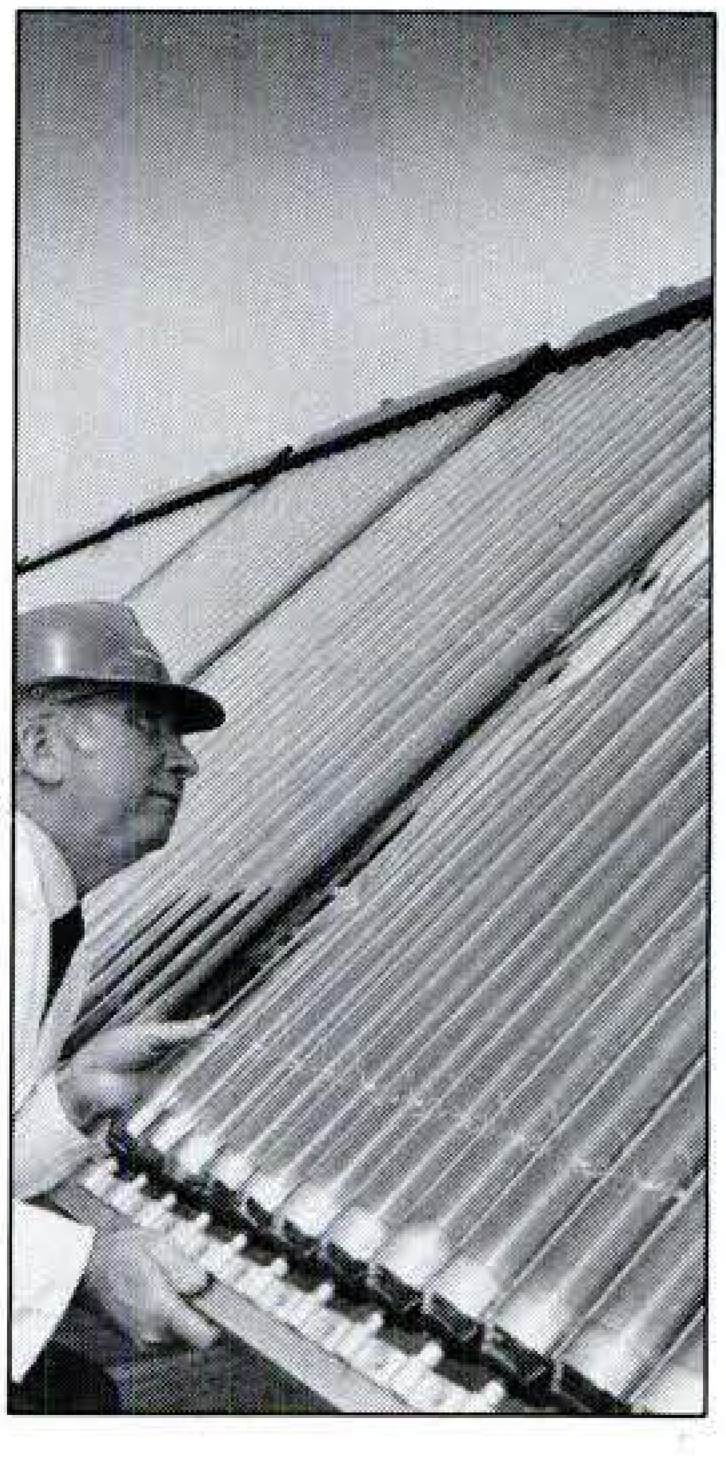


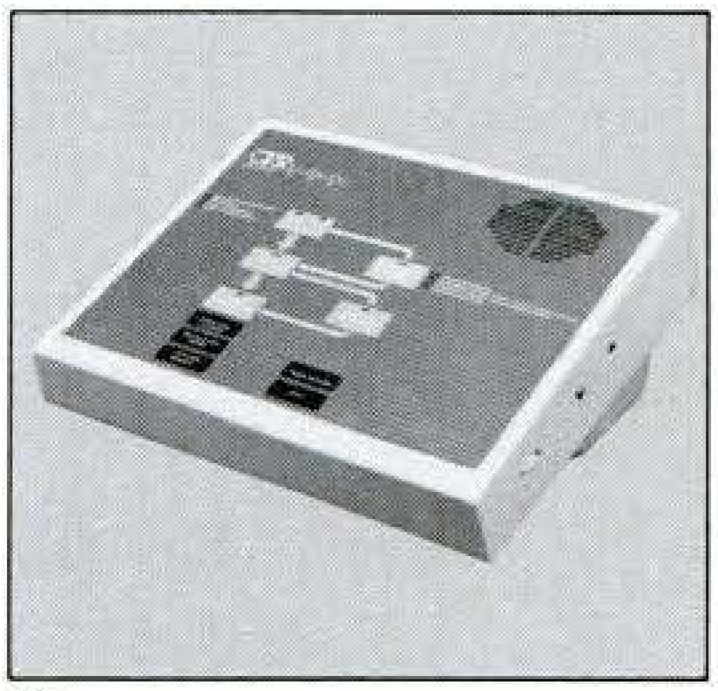
Tunnel tests

Made by Grumman, the X-29 aircraft appears to be flying backward [PS, April '80]. Stability tests at the USAF Arnold Engineering Development Center transonic wind tunnel saved money by substituting for 10 flights at increments of Mach number and attack angle.

Safer solar

Glass tubes collect the sun's energy, and a heat pipe transfers it to manifold water. Vacuum tubes lower heat loss and eliminate the danger of freezing; special fluid in the heat pipe prevents overheating. Thermomax, Balloo Crescent, Bangor, Co. Down, N. Ireland BT19 2UP.





Cardiac coach

Designed for emergency or training use, the $299 CPR Prompter has a microcomputer and synthetic-speech module to guide you through cardiopulmonary-resuscitation procedures. Display-panel lights and a voice provide the sequence. Auralogic Inc. (Norwalk, Conn).

What's New *in Electronics*

BY WILLIAM J. HAWKINS

Portable power

You can power video gear for about 5 hrs. with Gates's SideKick 5AH lead-acid battery pack. It has no "memory" like nickel-cadmium cells, so its built-in charger can be used anytime. The 6-lb. pack is $90. Gates Energy Products, 1050 S. Broadway, Denver, Colo. 80217.

Cordless set

The necessities of high-quality headphones: a 20-Hz to 20-kHz frequency response, a 60-dB signal-to-noise ratio, and less than 1% distortion. What's missing? Wires. Koss's Kordless phones receive your hi-fi's audio from a transmitter (bottom) via infrared light. $150.

Data saver

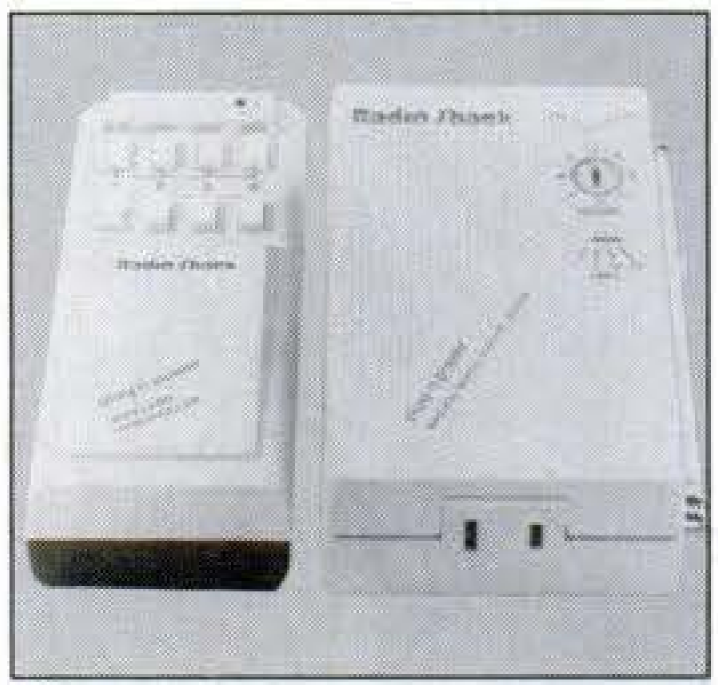
You've just entered your inventory into Sharp's new pocket computer. Now what? Save it. Unlike other pocket portables, the PC-1600 lets you store data on an optional ($210) 2.5-in. floppy disk. The $345 16K computer is expandable to 80K and contains BASIC.

CALC. VCR TV STEREO
JAN
FEB
MAR
SHARP
POCKET COMPUTER PC-1600
SPACE
ENTER

48.02 digirain
A
B
C
1 2 3 4 5 6

Rain gauge

The spherical water catcher goes outside your house; the Digirain box goes inside. Result: You see a digital display of daily and monthly rainfall that's accurate to $\frac{1}{100}$ mm, claims distributor Consel Marketing (8898 Clairemont Mesa Blvd., San Diego, Calif. 92123). It's $99.



Message sender

Touch a button on your instrument panel, and you can send the driver behind you a greeting... or something similar. The TaleLights display has nine messages to choose from. It's made by Willas USA, 20315 Nordhoff St., Chatsworth, Calif. 91311, and costs $200.

Wireless remote

Radio Shack's $40 Remote Control Center lets you turn on the house lights as you pull into the driveway. The receiver (right) plugs into a wall socket. From then on, any X-10-compatible module in your home can be controlled via the transmitter (left) from up to 300 ft. away.

EVERY BUSINESS NEEDS AN IBM-PC

WHO WANTS TO PAY IBM PRICES?

WE HAVE A SOLUTION!!!

FACTORY DIRECT
$799.
STANDARD MODEL

~~100 Compatible PC-XT~~
~~BASE P $950.00 LEASE $39~~
~~With 20 M Har isk $1399.00 LEASE $56/MO~~

CALL

Upon Approved Credit

Our **PC-XT SUPER TURBO COMPUTER** runs all the popular Business Programs, like Lotus 1, 2, 3, Word Perfect, Wordstar, dBase III, Homebase, Sidekick, and Flight Simulator. In addition to running the programs at the standard IBM clock speed of 4.77 Mhz, it also runs at 8 Mhz — **almost twice as fast as IBM**.

ACS has developed the fastest, most powerful XT and AT computers available today. We have also researched the numerous software programs available to automate your office. If you are considering buying a computer, call ACS. We can recommend the software and hardware system that will best solve your business needs.

HERE'S WHAT YOU GET

ACS-Turbo Mother Board 4.77/8.0 Mhz
640K of RAM
Two 360K Floppy Drives
Heavy Duty 135 Watt Power Supply
Keyboard New ''AT'' Type with Large Enter Key
Parallel Printer Port
Monochrome Graphics Display Card
High Resolution Mono Monitor
  with Swivel Base and Anti-Glare Screen

OPTIONS

20 MEG Hard Disk	$449.00
20 MEG Tape Back-Up	$595.00
Clock/Calendar	$ 59.00
Internal Modem 300/1200 BAUD	$199.00
Okidata 192 Printer	$399.00

PROGRAMS INCLUDED

Included in the purchase price is MS-DOS, the standard IBM operating system. With our Hard Disk Computer, you also get HOMEBASE, a general purpose multi-function program to perform word processing, electronic filing, and data base management. HOMEBASE has a built-in calendar, with monthly, weekly, and daily scheduling. The Homebase Calculator lets you perform calculations on the monitor and the ability to print a paper tape if desired. HOMEBASE also includes a communication program with autodialer for communication with other computers (requires a modem).

5 YEAR WARRANTY AVAILABLE

GUARANTEE & WARRANTY

We guarantee you will be delighted with our **ACS-Turbo Computer** or return it within 30 days for a refund (less shipping charges). We warranty our Turbo Computer 100% Parts & Labor for 1 year. We believe our computer is even more reliable than IBM — that's why we're offering a five-year extended warranty for only $30.00 a year. Order early for the holidays — delivery may take over 30 days.

HOW TO ORDER

Call us at (818) 889-1092. We have experienced salespeople to advise you with your computer requirements. Ask for our experts — ask for Department FD.

You can charge our **ACS-Turbo Computer** with a VISA or MasterCard. We also have a lease plan available for qualified businesses, with payments from 36 months to 60 months.

*IBM is a registered trademark of International Business Machines.

DEALERS WANTED

ACS

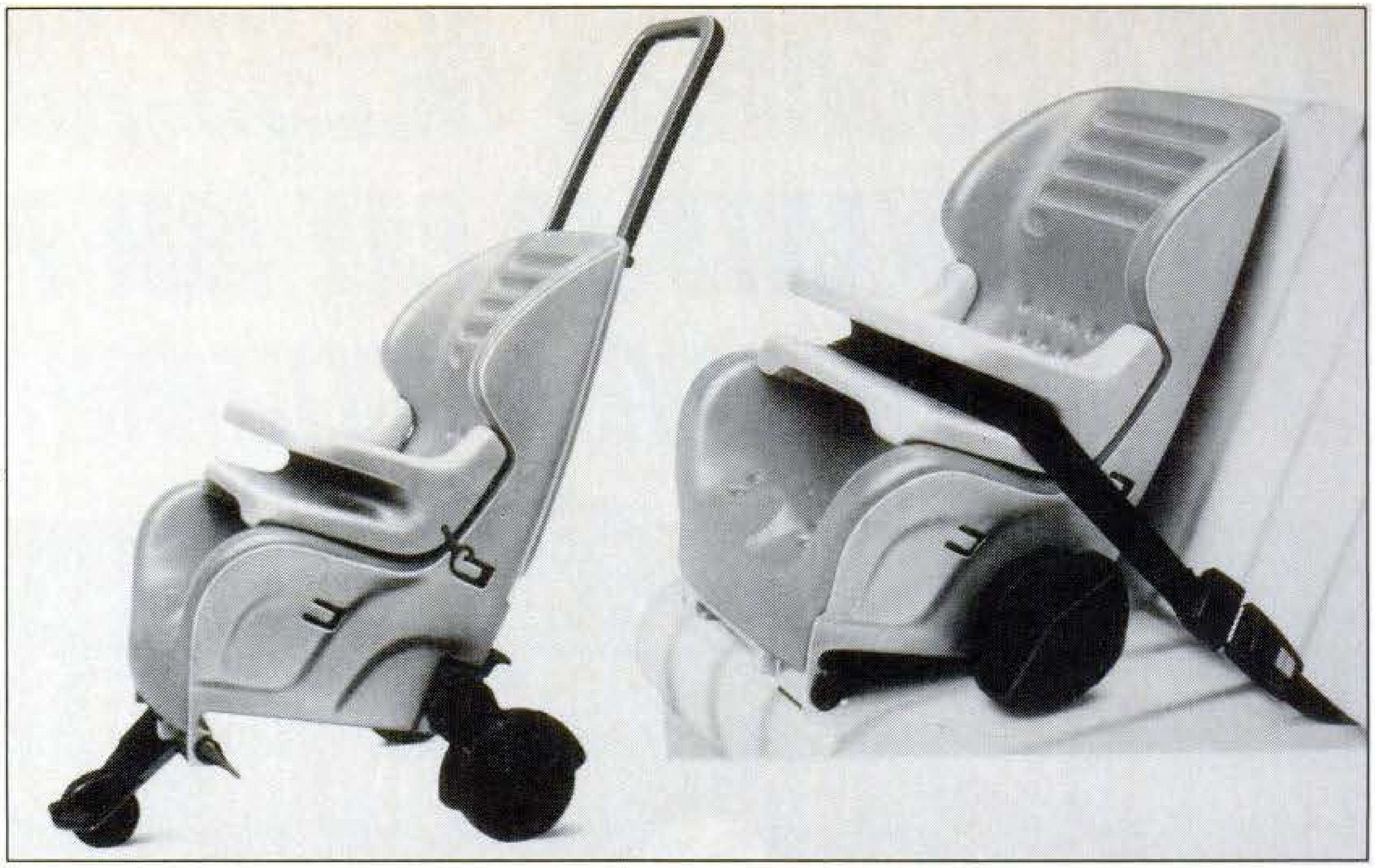
5311 Derry Avenue, Suite A, Agoura Hills, CA 91301
Phone: 818/889-1092 Fax: 818/889-5605 Telex: 299 353 POST UR
EASY LINK Mailbox: 62941735 Telex: 5106018224 ACS AGRA HILLS UQ

What's New
for Your Car

BY JACK KEEBLER

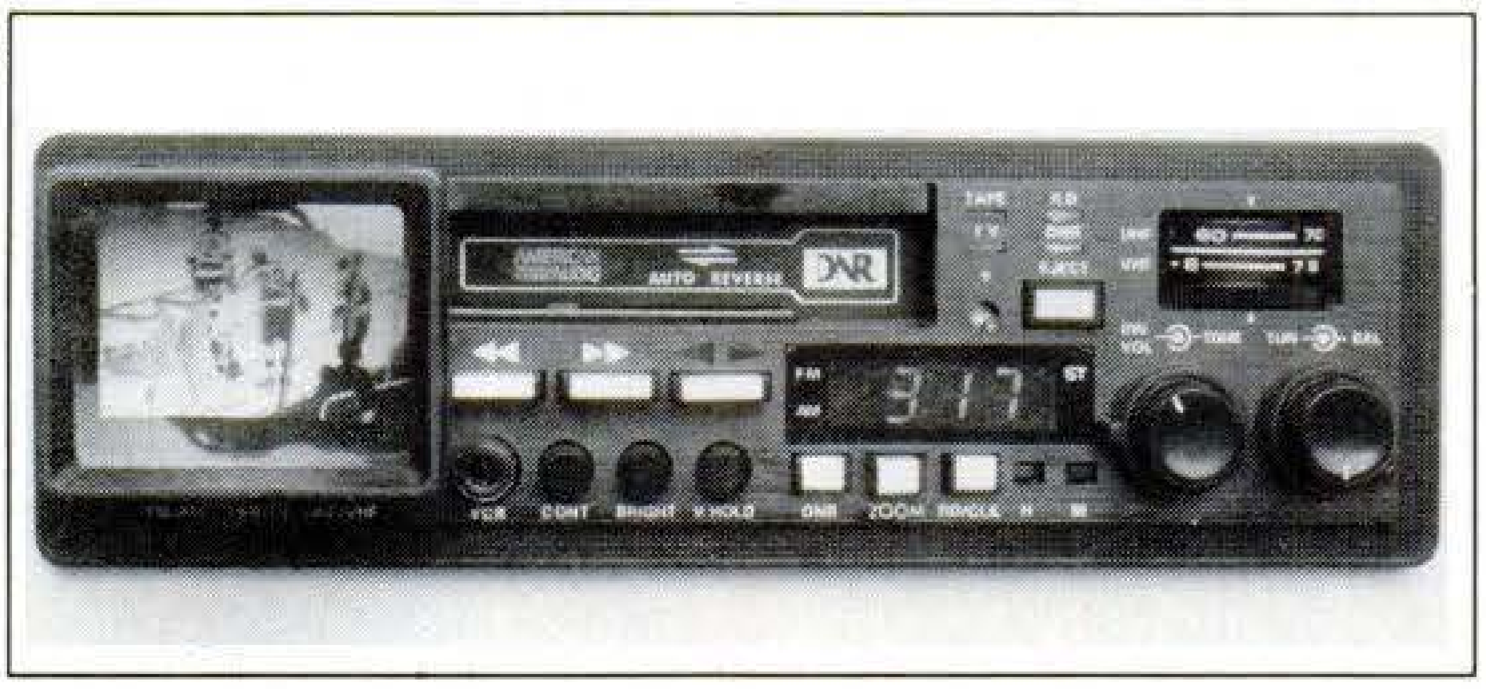
Car-seat stroller

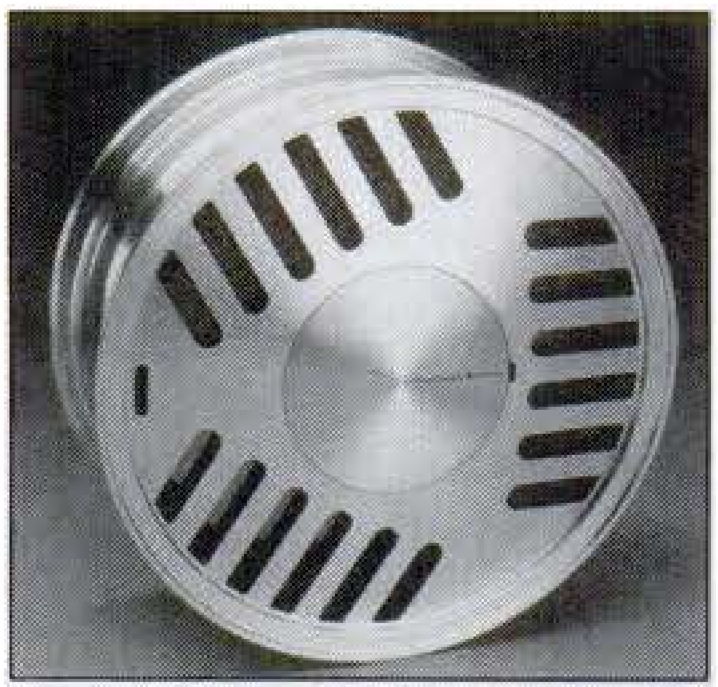
Retractable wheeled legs convert this car seat into a stroller suitable for 8-mo.- to 4-yr.-old children. Mudguards on the wheels prevent soiling the car's cushion, and wipe-clean plastic covers the seat molding. Vitaloni Brestrom, Via Torino 76, 10040 La Cassa (TO), Italy.



Car-panel TV

Spend a lot of time in your car? This video system features a cassette player, AM-FM radio, digital clock, and 2-in. monochrome TV, which works only with the key in the accessory position. Made by American Cytech, 5700 W. Broadway, Crystal, Minn. 55428, it's $299.





Smooth-face wheel

Available for front- or rear-drive cars, the Aries aluminum wheel comes in 13-, 14-, and 15-in. sizes. Clear lacquer protects the machined face from weather and road chemicals. American Racing Equipment (17600 S. Santa Fe Ave., Rancho Dominguez, Calif. 90221). $116–$143.

plasti-kote
IMPORT COLOR

Import touch-up

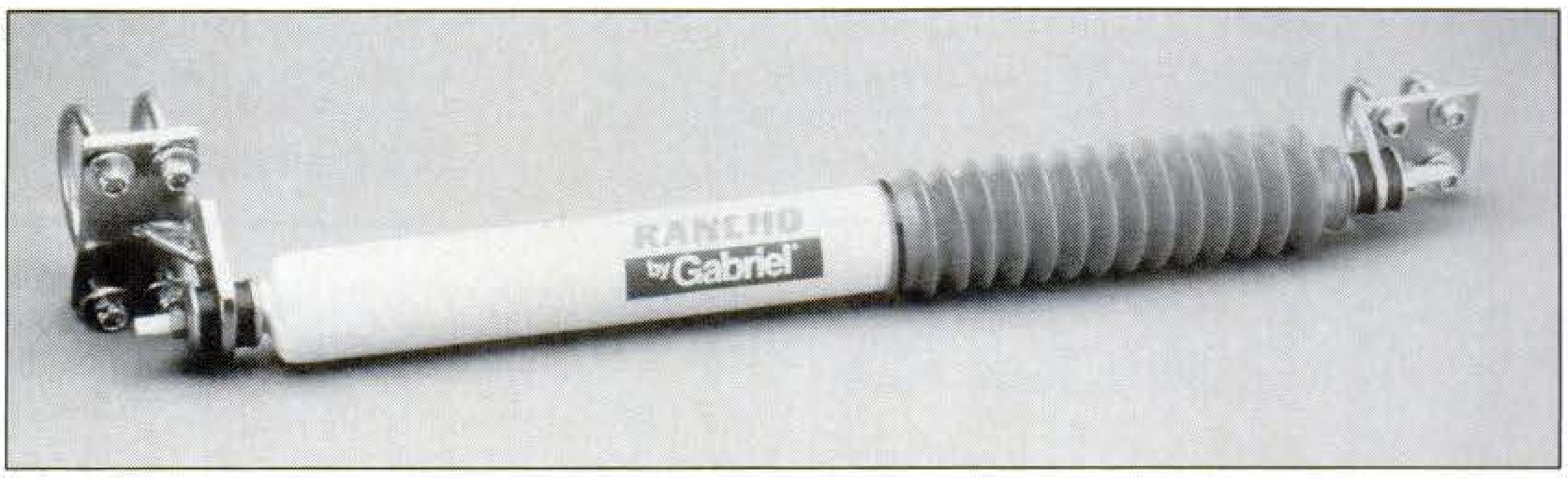
Can't find the proper color touch-up spray for your import? Plasti-Kote claims these shades are computer matched to the car manufacturer's precise standards. The selection includes colors for Toyota, Nissan, Honda, VW, Mazda, and Subaru models. $4.45 (8 oz.).

Fuel tool

Made of high-density polyethylene, these lightweight, crushproof, and rustproof gasoline carrying cans are available in 1½-gal. ($7) and 2½-gal. ($10) sizes. Detachable spouts fit inside the cans for storage. Maker: Echo, 400 Oakwood Rd., Lake Zurich, Ill. 60047.

Steering stabilizer

Designed to dampen abrupt steering-wheel torque caused by off-road terrain and highway ruts, the Rancho by Gabriel can be installed in 10 to 20 min. The damper features an O-ring piston seal, zinc-anodized brackets, and a polyurethane dust boot. Price: about $40.



Save Gas, Save Engine with 'POLY'

The following introduces one of the most fully tested and credentialed gas saving, friction reducing engine treatments ever to reach the market!

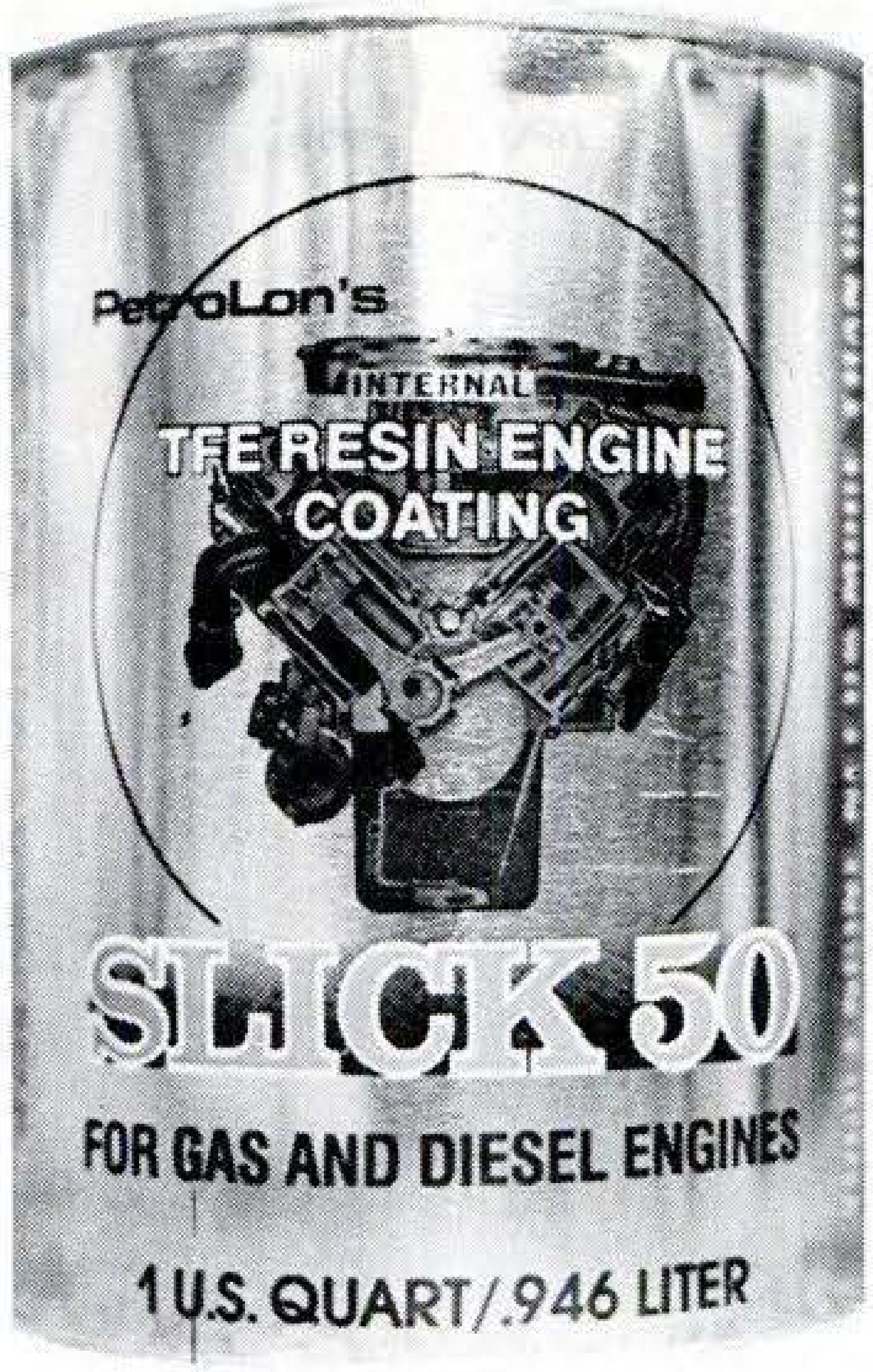
WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man **(1981 Guiness Book of World Records, p. 188).** The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The **"Consumers Digest"** magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about two or three miles per gallon.... Slick 50 does exactly what Petrolon claims it does." Researchers at a **nationally respected research laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **Federal Aviation Administration** has fully accepted a similar product- Slick 50 Aircraft Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

"Dune Buggies and Hot VW's" magazine, April 1983, p. 70-71, records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work and that it does reduce engine wear!.... for the price of one treatment when compared to engine rebuild, we feel you'd be money ahead using Slick 50."

A test done at the **San Diego State University** revealed that, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.



Perhaps the most dramatic of all is a torture-test overseen by the **Automotive Services Council for Pennsylvania** and shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. There are many more tests available. If you are still skeptical, send $2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. Just before oil and filter change, add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filter and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal. Once impregnated it is permanent, so **you do it only once**, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OIL? Yes, Slick 50 will work with all petroleum based oils and all synthetics compatable with petroleum based oils.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, etc. By reducing friction, Slick 50 does all of the following: it **increases gas mileage**. It **increases horsepower** -- small economy cars and large RV's really need this. It makes for **easier starting** (important in cold weather). It **reduces operating temperatures**, thus increasing the lubrication and life of your oil and your engine. Since lubricating lead is being removed from gas and unleaded gas is poor in lubricating qualities, the **extra lubrication of Slick 50 on valve stems and guides is very valuable**. Last, but not least, the drastic reduction in engine wear **defrays or eliminates costly overhauls** which can save you over $1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the wear on a car can be caused by this lubrication starvation. You receive all of these benefits for **less than the cost of two tanks of gas** ($39.95).

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturers engine warranty requirements. In addition, this oil carries an API (American Petroleum Institute) service classification SF-CC-CD.

DEALERSHIPS ARE AVAILABLE.

OTHER SLICK 50 PRODUCTS available are Gear Treatment (manual transmission, etc.), 2-Cycle Engine Treatment, Grease, Ultra 9 Oil, Fuel Conditioner, and Fabric Protector. Free information is sent upon request.

EASY TOLL FREE NUMBER. Since Slick 50 is **"too too Slick"** for engine friction, our toll free number is 1-800-22-SLICK (that is, 1-800-227-5425).

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information call toll free 1-800-22-SLICK, (in Colorado, call 1-303-667-1715) or send to: FORT MORGAN SLICK 50, 407 Del Rio Road, Berthoud, Colorado 80513.

PS10

☐ I enclose $39.95+$4.00 shipping & hand.
☐ I want 2 or more (free shipping & hand.)
☐ Check ☐ C.O.D. ☐ Visa/MC

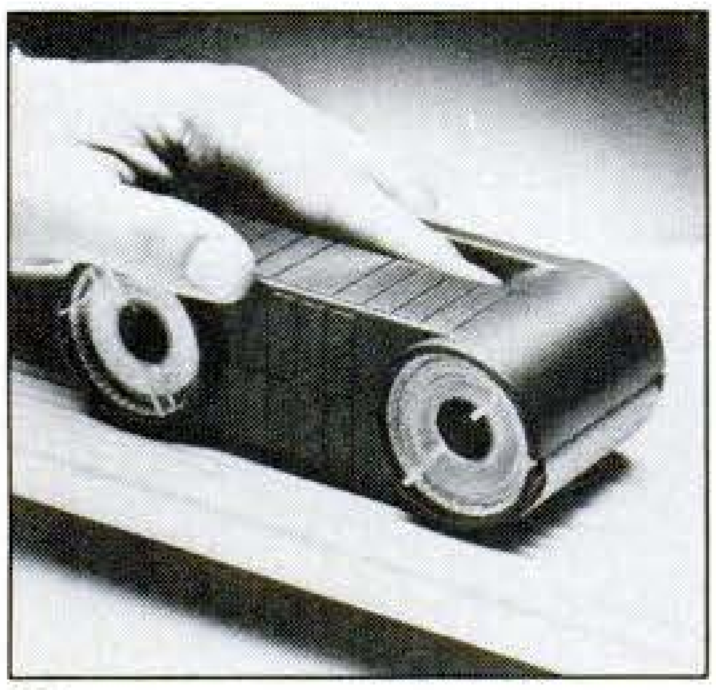
Card # ____________ Exp.__
Name ____________
Address ____________
(Give street address for U.P.S. delivery)
City ____________
State ____________ Zip ______

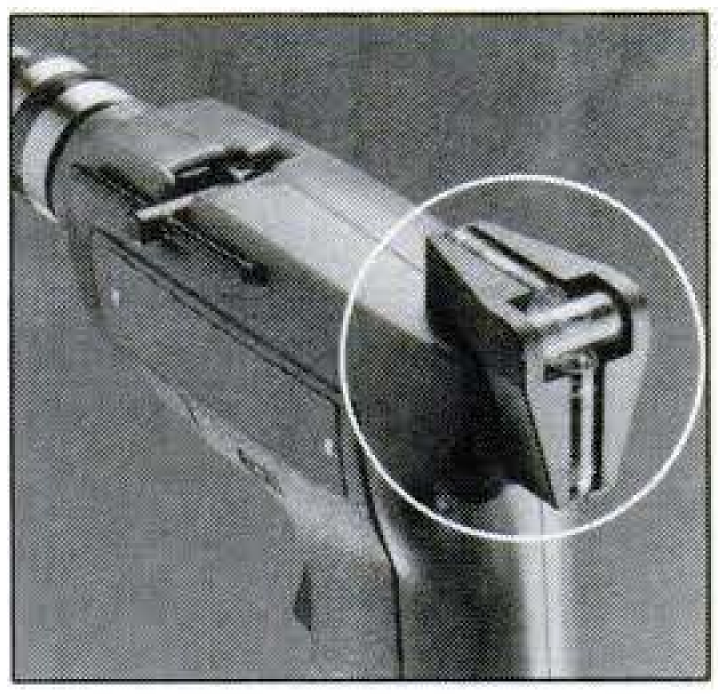
What's New *in Tools*

BY V. ELAINE GILMORE

Pro drill

The newest drill from Skil: a ⅜-in. variable-speed-reversing model with a 3.5-amp motor—powerful enough to please the pros, according to the company. Ball and roller bearings ensure long life and smooth operation, it's claimed. Speed range: 0–2,500 rpm. Price: about $68.





Hole straightener

Here's a $6 solution to the problem of drilling crooked holes. Dril-Level's three bubble levels help you keep the drill straight—vertically and horizontally. Adhesive-backed rubber pads stick it to the drill case. Dejon Tool & Products, Box 1346, Lancaster, Ohio 43130.

Deep cuts

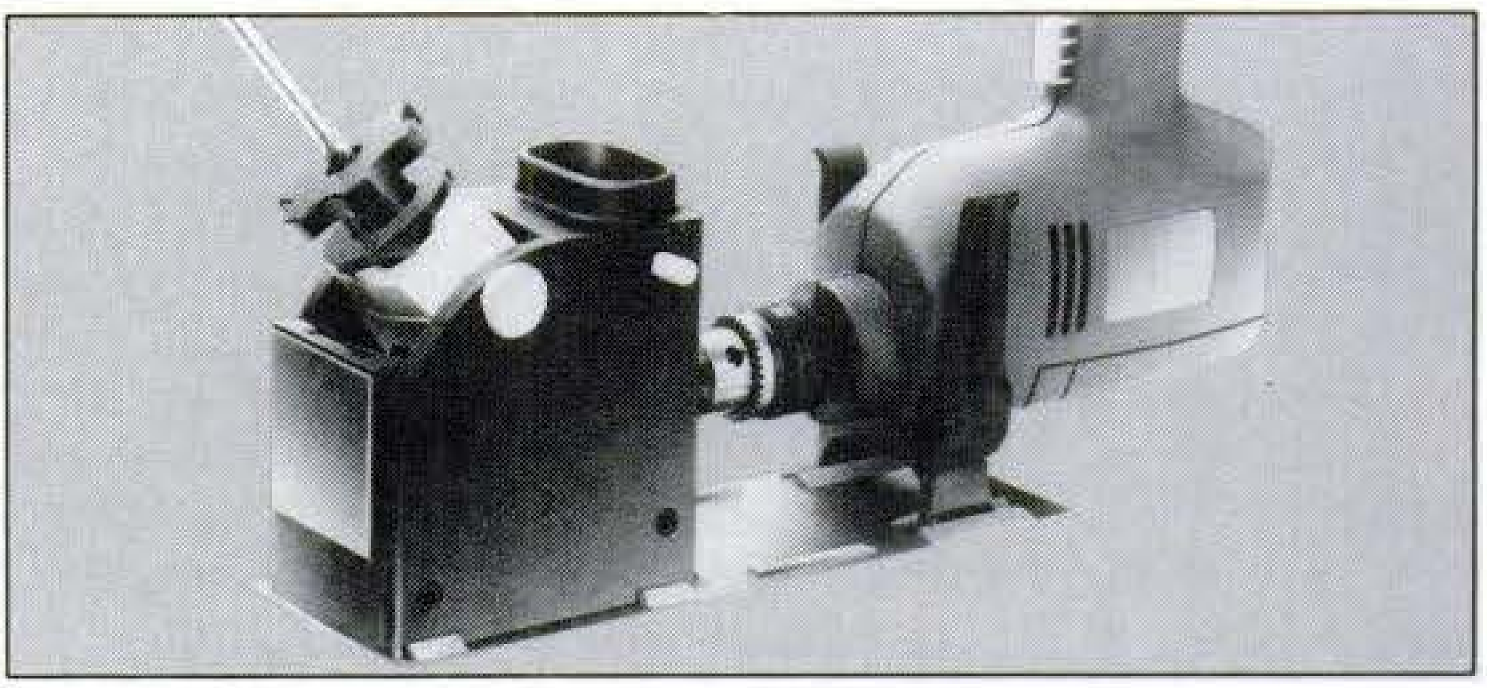
Foley-Belsaw's latest 10-in. table saw gives a 3½-in. depth of cut and is powered by a 1½-hp motor. The saw's Accu-Fence ensures unbeatable accuracy, it's claimed. The model 490 sells for $899. Foley-Belsaw, 6301 Equitable Rd., Box 419593, Kansas City, Mo. 64120.

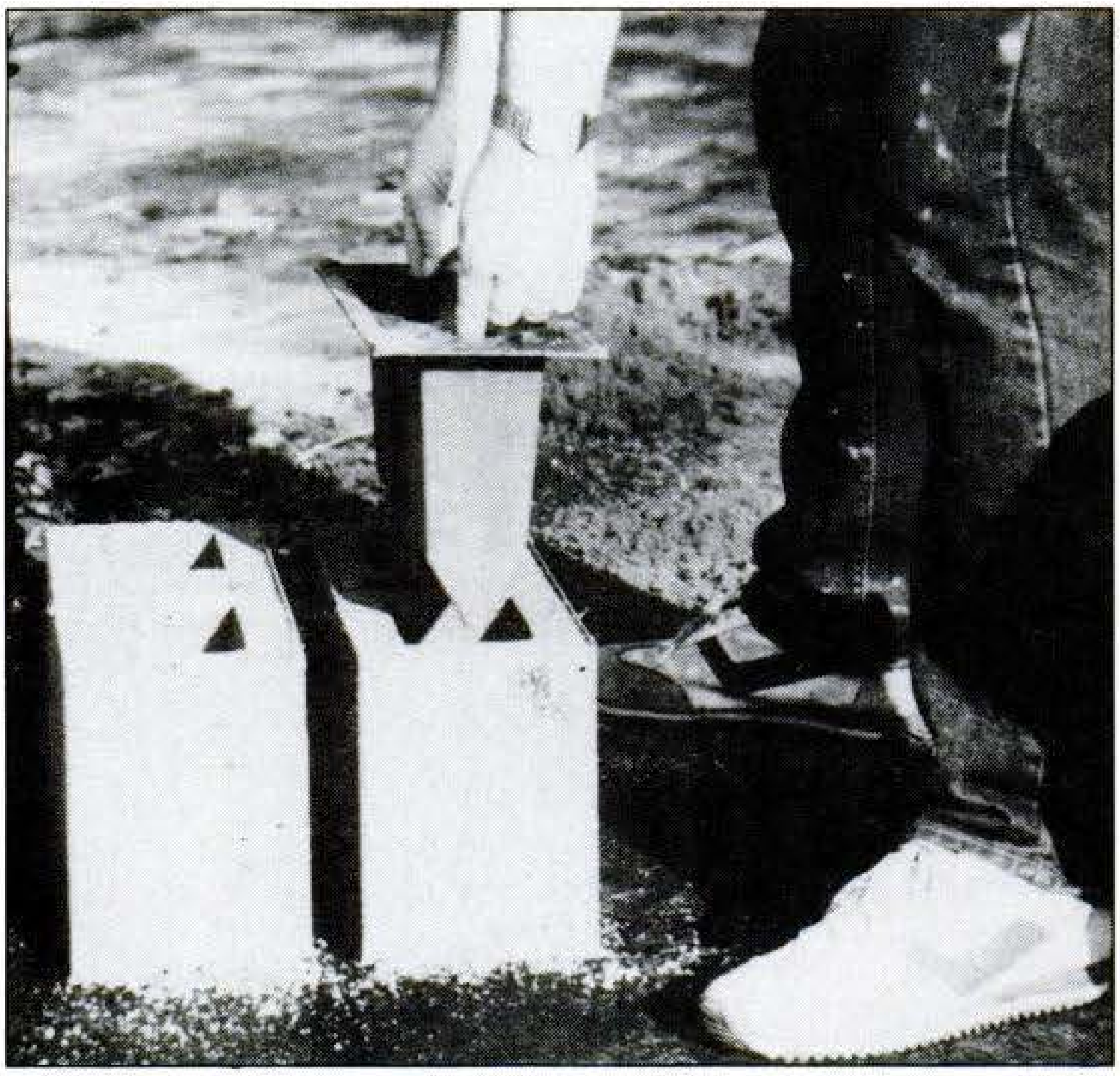
Cartridge sander

With the David Cassette Sander, you roll up old sandpaper onto one spool while you roll out new from another. To change grits (50, 80, or 120) you change cassettes. Suggested price is $10; replacement cassettes are $2. Themans, 5721 Bayside Rd., Virginia Beach, Va. 23455.

Bit partner

This electric-drill-powered tool makes bit sharpening as easy as sharpening pencils, it's said. It sharpens steel and masonry bits up to 12.5 mm dia., with tip angles of 80°, 118°, and 130°. Martek Ltd. (Box 20, Redruth, Cornwall TR15 2UF, England). About $45.



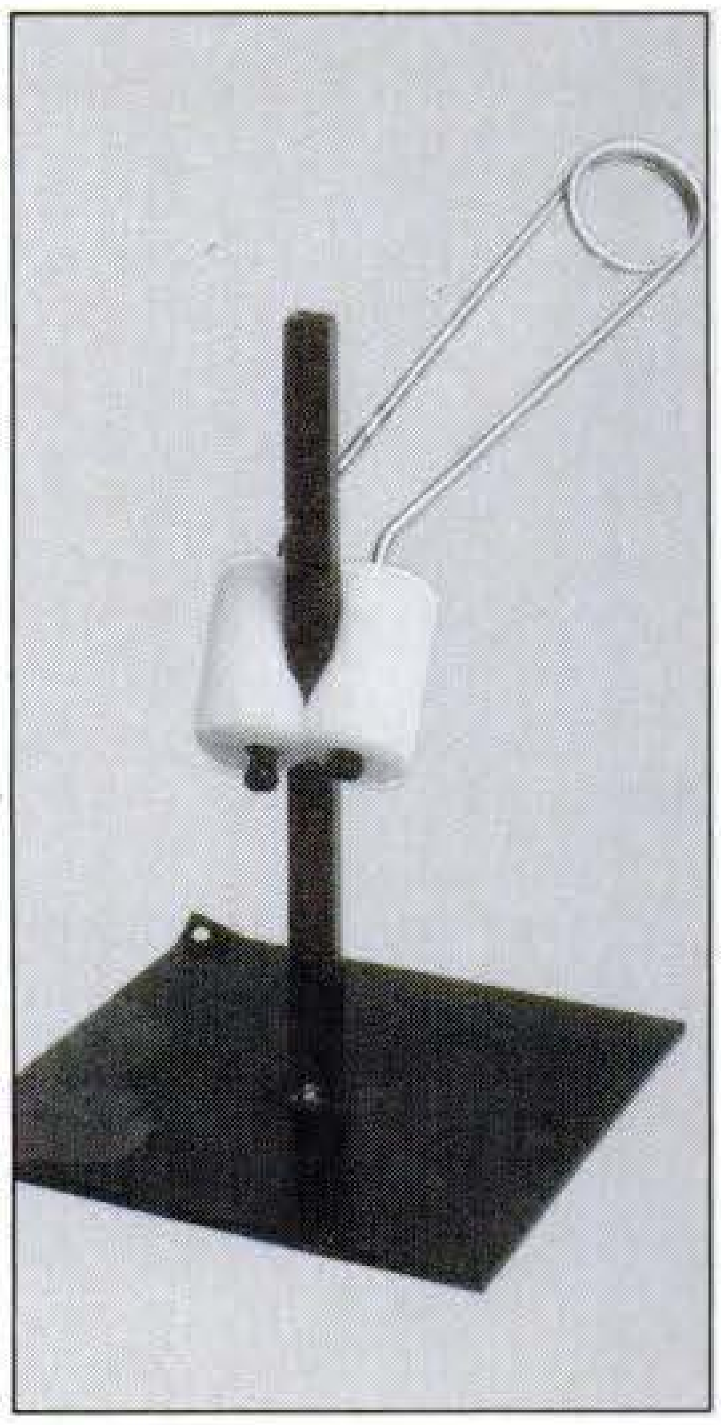


Block maker

Fill the mold with concrete, tamp it, turn it upside down, and remove the two-part mold: After a 1½-day cure, you have ready-to-use concrete blocks. Price of an 8-in. mold: $395 in steel, $195 in wood. Plans are $10. E-Z Block Mold Co., Box 28747, St. Louis, Mo. 63146.

Pipe painter

It's fast and neat, and it doesn't waste paint, claims the maker of the Wrought Iron Painter. You coat the double rollers with paint, slip them around a pipe, dowel, or bar, and roll on the paint. With six refills, it's $7. J&J Sales, Box 261229, Suite 321, San Diego, Calif. 92126.



Radio Shack Breakthrough! The First High-Performance Satellite TV System You Can Install With Ordinary Hand Tools

Radio Shack
High-Efficiency Feedhorn With Weatherized Housing
Dish Features Wire Mesh Design for High Strength And Low Wind Loading
Rotatable Hub For Fast and Safe Assembly From the Ground, No Ladder Needed
Precision Gear Motor Drive Provides Full 180° Coverage
Heavy-Duty Mast With Built-in Bubble Level

Now Available With Your Choice of 8½-Foot Dish or New 10½-Foot Dish

Radio Shack's satellite TV system brings you over 100 channels of quality entertainment. Enjoy sports, movies and music videos with stereo sound, networks, super stations, kids' shows and much more. This complete block down conversion system includes instructions and an assembly guide on video cassette. Only $1995 with 8½-foot dish or $2295 with 10½-foot dish. Selected components available for upgrading existing systems. Credit plans available. Come in for details.

G 124
REALISTIC

Digital synthesized receiver provides automatic dish positioning and stereo sound tuning, outputs for TVs and TV monitors, stereo audio amp and descrambler.

Radio Shack®
The Technology Store
A DIVISION OF TANDY CORPORATION

Price applies at participating Radio Shack stores and dealers.

Send Me More Information!

Mail to Radio Shack, Dept. 87-A-229, 300 One Tandy Center, Fort Worth, TX 76102

NAME

ADDRESS

CITY

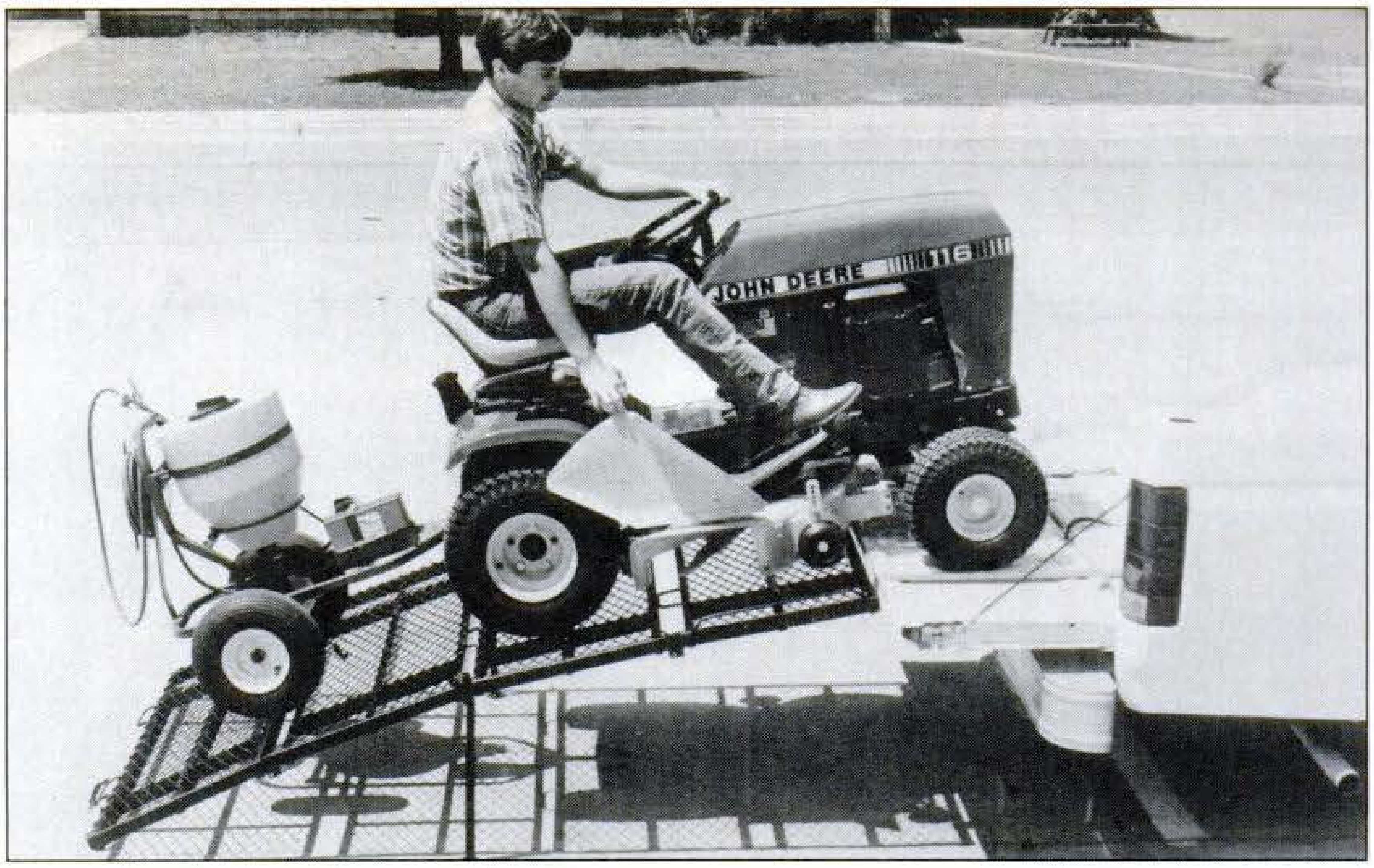
STATE

ZIP

Copyrighted material

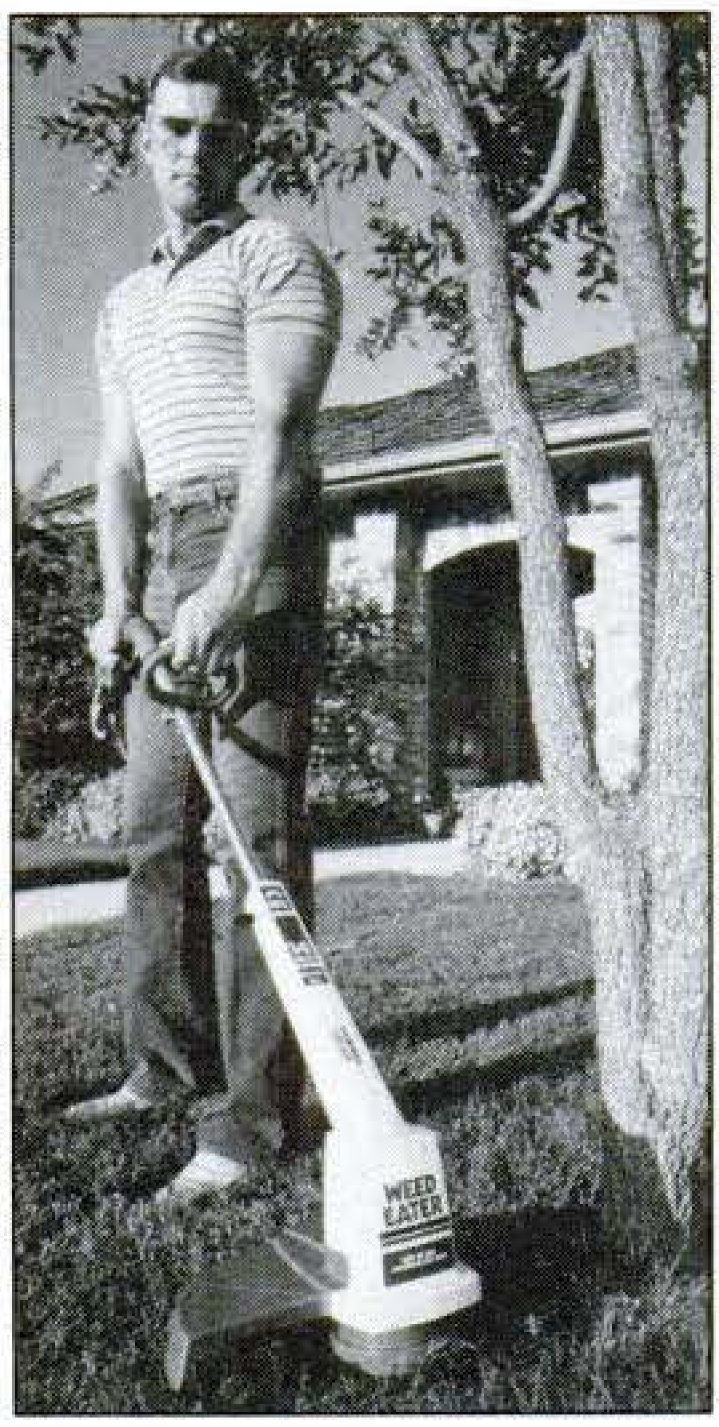
What's New
for Your Lawn and Garden

BY TIMOTHY O. BAKKE



No-slip ramp

Made of expanded-metal gridwork and a steel frame, Handy Ramp (First Products, Box 1425, Tifton, Ga. 31794) fits both full-size and compact pickups. It measures 48¾ by 82 in., weighs 92 lbs., and stores on edge in 10 in. of space. Maximum capacity: 1,000 lbs.; $300.

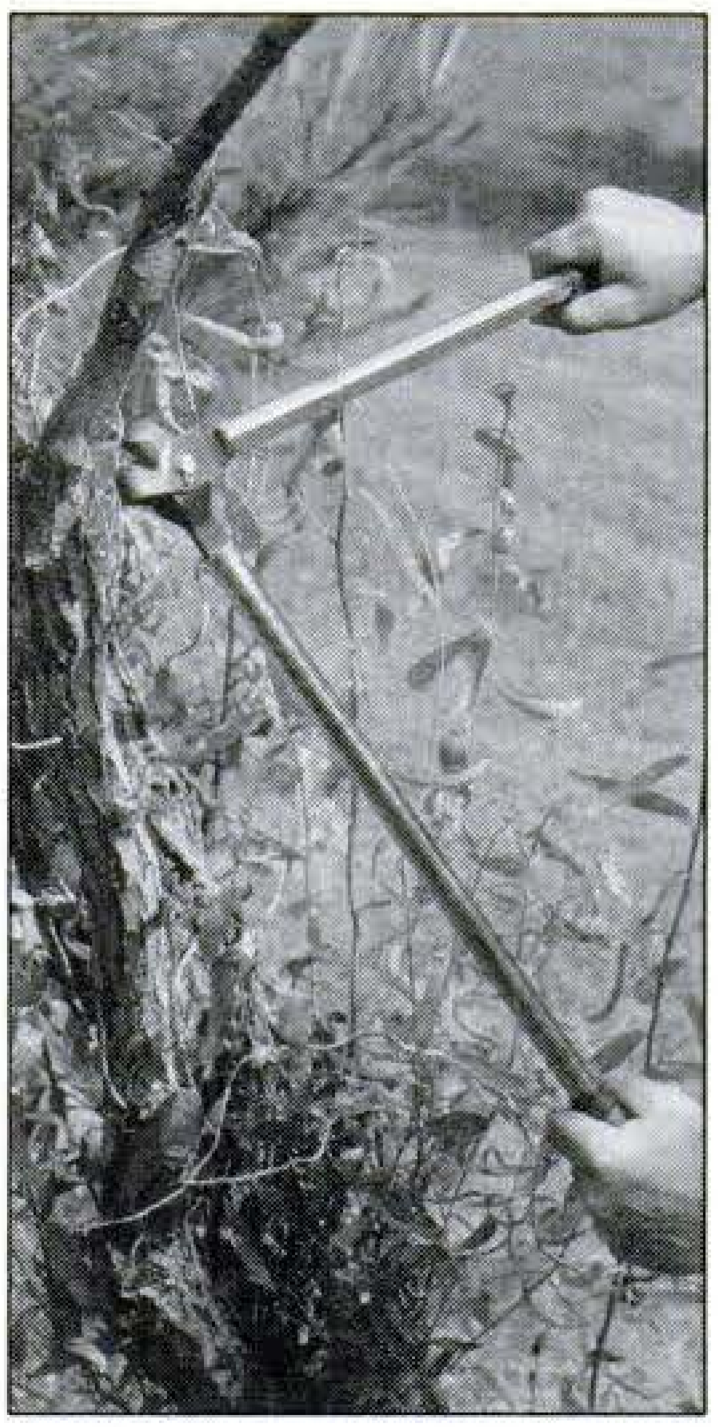


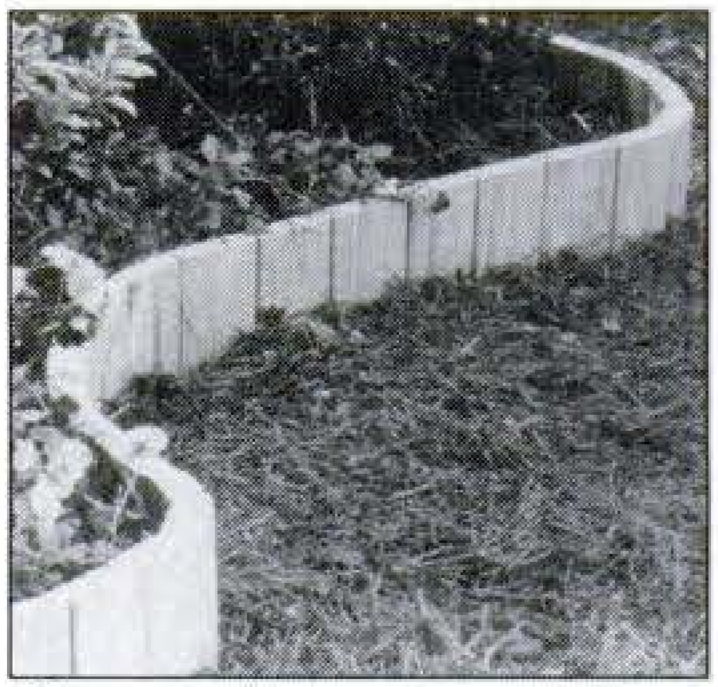
Trim trimmer

The lightweight electric model 1214 string trimmer from Weed Eater weighs just 6.3 lbs., but it has a heavy-duty 3.5-amp motor and cuts a 14-in. swath. Also, the motor can be rotated to the vertical position while the handle stays put for easier edging. Price: $50.

Big-branch cutter

A limb that's too thick for a shear-type pruner is no match for the heavy-duty cutter from Chipper Sales (19827 W. 12 Mile Rd., Southfield, Mich. 48076). The jaws of the all-metal trimmer are designed to cut out chunks of wood, so they actually bite through a branch. $23.





T&G edging timbers

Take 30-yr. treated lumber and add a tongue-and-groove design that allows flowing curves. Result? Edging made by Create-A-Scape (Box 32250, Raleigh, N.C. 27622). It comes in 3-ft. kits (1⅜ by 5½ by 6 in. high; $5) or as bulk lumber (1¾ by 5½ in.; 85¢ a ft.).

Simplicity

Weekend workhorse

The latest entry from Simplicity is the twin-cylinder air-cooled 18-hp Sunstar tractor. It features a double-pivoting front axle for better maneuverability plus shaft-driven attachments, including a 60-in. mower, 42-in. snow thrower, vacuum collector, and tiller. $5,000.

High-rev chain saw

The CS-4500 saw uses a vertical-cylinder design that allows it to run 2,000 rpm faster than conventional horizontal-cylinder chain saws, says Echo (Lake Zurich, Ill.). It has a fairly large (48-cc) engine, but it weighs only 11 lbs. With an 18-in. guard-tip bar, it's $360.

Scientific study ranks NordicTrack #1

In tests of exercise efficiency at a major university, NordicTrack burned more calories and provided greater aerobic workouts.

Bill Koch

8 time National
X-C Ski Champion
Olympic Silver Medalist
World Cup Winner

NordicTrack Pro
With Adjustable
Elevated Legs

The Rank in Order of Exercise Efficiency:

1. **NordicTrack**
2. **An Exercise bike**
3. **A Rowing machine**
4. **A Shuffle type ski exerciser**

Scientific abstract available upon request

All Exercise Devices Were Tested 4 Times:
at 3 different heart rates and at maximum work.

Tests Measured:
Volume of oxygen consumed which indicates calories burned.

Data was scientifically analyzed at the University Human Performance Laboratory.

Results:
On all 4 tests, NordicTrack burned more calories and yielded significantly greater cardiorespiratory workouts.

It's Only Logical that NordicTrack Would Get the Highest Scores

because NordicTrack is more complete than an Exercise Bike.

NordicTrack adds important upper body exercise.
NordicTrack provides more uniform leg muscle usage.
Higher pulse rates, necessary for building fitness, seem easier to attain because more muscles share the exercise.

because NordicTrack provides more thorough exercise than a Rowing Machine.

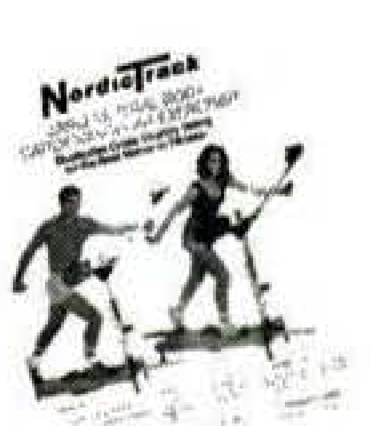
Standing position involves more muscle mass than sitting position.
NordicTrack uses large muscles of buttocks, thighs and calves to simultaneously bear body weight and work against resistance.
NordicTrack resistance is proportioned to individual muscle strength.
Stronger legs use greater resistance.
Arm resistance can be set at lighter setting separately.
NordicTrack is safer — no high back strain loads are imposed.

because NordicTrack has inertial resistance not available on a Shuffle-Type Ski Exerciser.

Flywheel provides life-like feeling; Smooth, Continuous.
Other "ski" exercisers without flywheels use only frictional resistance.
Result is stop-start calisthenics-like feeling.
NordicTrack's clutch system allows true ski striding motion.
Other ski exercisers require less efficient shuffling motion.

Burns Up to 600 Calories per 20 Minute Workout.
For effective weight control.

Free Brochure, Call
1-800-328-5888
Minnesota 612-448-6987



NordicTrack

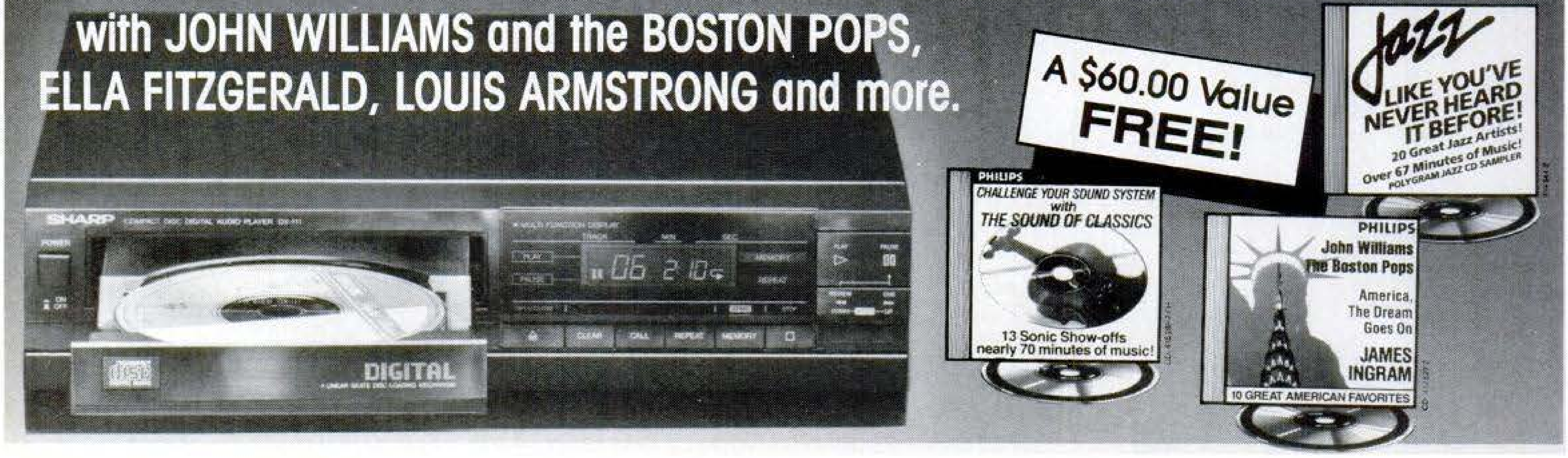
©PSI 1986

141PS Jonathan Blvd. North, Chaska, MN 55318

Now—from THE COMPACT DISC MUSIC GUILD...

TAKE THIS $360 SHARP COMPACT DISC PLAYER FOR ONLY $179⁹⁵-GET THE GREAT TREASURY OF MUSICAL FAVORITES FREE!

with JOHN WILLIAMS and the BOSTON POPS, ELLA FITZGERALD, LOUIS ARMSTRONG and more.


A $60.00 Value FREE!
Jazz LIKE YOU'VE NEVER HEARD IT BEFORE!
20 Great Jazz Artists!
Over 67 Minutes of Music!
POLYGRAM JAZZ CD SAMPLER
PHILIPS
CHALLENGE YOUR SOUND SYSTEM with THE SOUND OF CLASSICS
13 Sonic Show-offs nearly 70 minutes of music!
PHILIPS
John Williams
The Boston Pops
America, The Dream Goes On
JAMES INGRAM
10 GREAT AMERICAN FAVORITES
SHARP
DIGITAL

EXPERIENCE the Incredible World of "CD" Music for 10 Days FREE!

• No "Commitments!" • No Clubs to Join! • No Obligation to buy anything additional, EVER! • FREE Treasury . . . almost 3 hours of Pops, Jazz and Classical Selections on 3 CD's!

If you enjoy music you simply MUST hear the new, **SHARP** Compact Disc player now available at an extraordinary introductory price direct from **THE MUSIC GUILD!** "CD"'s are actually COMPUTER DISCS. Each Disc has a playing time of as much as an hour and a quarter—and the music is actually "read" by a laser beam—so there is NO SURFACE NOISE, NO CLICKS, NO POPS, NO RECORD WEAR (even after thousands of playings!) and VIRTUALLY NO DISTORTION OR COMPRESSION OF THE DYNAMIC RANGE.

Until now, if you wanted to add a LASER, "CD" PLAYER to your present music system, you might have to spend as much as $300 for the player alone. **Now,** to introduce this fabulous new technology, **THE COMPACT DISC MUSIC GUILD** HAS MADE A SPECIAL ARRANGEMENT TO OFFER AN EXTRAORDINARY, "PROGRAMMABLE" CD PLAYER—AT A PRICE THAT SIMPLY CAN'T BE APPROACHED! And, Installation is as simple as plugging the supply cable into your existing stereo amplifier.

BUT THERE IS MORE.

Together with your new SHARP CD PLAYER—we'll send the fabulous 3 DISC TREASURY OF MUSICAL FAVORITES WITH THE BOSTON POPS, BILLIE HOLIDAY, MEL TORME—music by Strauss, Bernstein, Gershwin, Rogers and Hart—songs like **This Land Is Your Land, Stardust, When the Saints Go Marchin' In.** More than 44 selections that will stir the imagination and thrill every member of your family!

The Treasury ALONE IS A $60 RETAIL VALUE—but you receive it **AT NO EXTRA COST.** Imagine—A TOTAL VALUE THAT APPROACHES $360—all yours now for only $179.95—actually less than you would expect to pay for this famous Sharp player alone!

WHY THE GUILD MAKES THIS OFFER

The **CD Music Guild**—produces and offers direct, by mail only, TREASURY COLLECTIONS OF MUSIC-exclusively on Compact Disc. We do not produce older type, LP recordings. **CD's are our ONLY business.**

We believe that once you have actually heard your favorite music on CD—you will never again want to buy LP's or cassettes. Further, since we have planned an aggressive production schedule for new CD material—we believe that, owning a fine player, you will be interested in our newer offerings of musical Treasuries. BUT, YOU ARE NEVER OBLIGATED TO PURCHASE ANYTHING. You order ONLY and EXACTLY what you want and need (or nothing at all!). We think this is "sound business" (excuse the pun!). We are willing to bet you do too!

10 DAY FREE Trial in your own Home

Take advantage of this FREE TRIAL OFFER IMMEDIATELY. Simply use the coupon attached or call our **TOLL FREE SERVICE NUMBER, 1-800-255-3472** (in Connecticut, 1-452-0203). You may use a major credit card for immediate service.

NO OBLIGATION

LISTEN TO THE PLAYER AND THE 3 DISC TREASURY FOR 10 DAYS. THEN, IF YOU ARE NOT DELIGHTED IN EVERY WAY—simply return the package for a full refund! You owe it to yourself to sample this exciting new dimension in home entertainment NOW.

LIMITED SUPPLY—PLEASE ORDER AT ONCE

A WORD OF CAUTION. Since their introduction, COMPACT DISCS have constantly been in short supply. We believe this situation will continue for the present at least. Our supplies too are limited. Orders will be processed on a first come, first served basis. Please act at once to avoid disappointment.

SOME OF THE SELECTIONS INCLUDED IN THE TREASURY

- AMERICA THE BEAUTIFUL
- STARDUST
- BODY AND SOUL
- PICTURES AT AN EXHIBITION
- WHEN THE SAINTS GO MARCHIN' IN
- WHAT A DIFFERENCE A DAY MAKES
- AMERICA, THE DREAM GOES ON
- HOE-DOWN
- MINUET
- BATTLE HYMN OF THE REPUBLIC
- CARNIVAL OF THE ANIMALS
- STARS FELL ON ALABAMA
- THE SWEETEST SOUNDS
- NEW YORK, NEW YORK
- THIS LAND IS YOUR LAND
- PRAYER OF THANKSGIVING
- ...AND MORE!

SHARP LASER BEAM COMPACT DISC PLAYER TECHNICAL SPECIFICATIONS

Random programmability; Search/Skip; 3 Beam Laser; LCD Readouts

Frequency response:	5-20,000 Hz
Dynamic range:	96dB
Total harmonic distortion:	0.005% (at 1kHz)
Wow & flutter:	Below measurable levels (Quartz accuracy)
Channel separation:	90dB (at 1kHz)
Error correction:	CIRC (Cross Interleave Reed-Solomon Code)
Infinite repeat key	
Dimensions:	13"(W) × 3⅛"(H) × 11¾"(D)
Weight:	8.2 lbs. (3.7 kg)

MAIL TODAY or CALL TOLL FREE—1-800-255-3472
10 DAY FREE HOME TRIAL

THE COMPACT DISC MUSIC GUILD DEPT. PS1086
41 Monroe Tpke, Trumbull, CT 06611-1315

YES—please RUSH my SHARP programmable CD player plus the free 3 Disc **Treasury of Musical Favorites**—everything I need to simply plug my player into my Stereo System and begin enjoying the miracle of Compact Disc music immediately. The total price for the entire outfit is only $179.95 (plus just $8.85 shipping, handling and insurance . . . total $188.80).

I understand that if I am not absolutely delighted I may return the outfit within 10 days for a complete refund.

☐ Check enclosed

Charge my credit card

☐ Visa ☐ MasterCard ☐ American Express ☐ Discover

Card number ________ Exp. Date ______

Name ________

Street ________

City ______ State ______ Zip ______

Telephone number (   ) ________

The WHAT'S NEW magazine
Popular Science

What's News

No sooner had last month's issue gone to press than yet another piece of evidence for the existence of the top-secret F-19 stealth fighter came to light. A plane widely agreed by experts to be an F-19 crashed in the Sequoia National Forest about 12 miles from Bakersfield, Calif. Air Force officials immediately sealed off a 50-square-mile area around the sight, apparently to make sure no revealing parts could be picked up by unauthorized individuals. The F-19 was apparently being test flown at night (so no one could see it) out of Edwards Air Force Base.

Atlantic record

A group of daredevils tried to beat the transatlantic speed record a few months ago. Stuart Brown told the story of that first attempt last November. Now the group has built another boat and made another attempt. Shortly before the craft left New York, Stuart went for a ride around the harbor (he's on the other side of the cabin in the photo on this page). Here's his report on the ride, and on the subsequent record attempt.

"British record and airline millionaire Richard Branson vowed he would try again after the speedboat *Virgin Atlantic Challenger* sank last year during his attempt to set a new transatlantic crossing record. He meant what he said. Late in June, *Virgin Atlantic Challenger II*, a 72-foot mono-hulled successor to the ill-fated catamaran, bettered by two hours and nine minutes the record that had been held since 1952 by the passenger liner *S.S. United States*.

"Several days before Branson and his six-man crew left on their record-breaking run, I joined them for a 60-mph blast down the East River and around New York Harbor. Four thousand horsepower certainly grabs one's attention. The turbulent white water churning off the stern rivaled a tugboat's wake as the two big turbocharged V-12 diesel engines whined and growled to bring the aluminum craft up onto the plane. Inside, heavily padded racing-car seats provided some respite from the fast boat's pitching and pounding.

"One honor, however, has eluded *Challenger II:* the Hales trophy. The transatlantic-crossing prize remains enshrined at the King's Point Merchant Marine Academy Museum in Long Island. Curator Frank O. Braynard refuses to surrender the trophy, contending that it's intended for passenger-carrying ships—not speedboats."

Propfan

Rohr Industries in San Diego, Calif., is testing NASA's new propfan [PS, March '85], and it should actually be flown in a test aircraft some time this fall. There seems little doubt that, as advertised, the new technology will give jet or near-jet speed and 30- to 40-percent fuel improvement. One ironic note: Boeing Aerospace Co., preparing to launch a new generation of propfan aircraft, now is suddenly wondering whether the whole deal is worth it. Just as new fuel-efficient airplanes are technically possible, the dropping price of jet fuel makes them far less attractive.

Heli-Stat tragedy

Frank Piasecki, one of the country's helicopter pioneers, had a dream. It was a blimp with a large frame attached. On each corner of the frame was mounted a helicopter. With the gas bag supplying most of the lift and the helicopters giving forward speed and maneuverability, the device, said Piasecki, would be useful in hauling lumber out of dense forests and doing other heavy lifting jobs. He called his dream machine Heli-Stat, and it was the subject of an article in POPULAR SCIENCE in November 1981.

Unfortunately, the dream ended in July when the Heli-Stat crashed. Three of the five crew members aboard were injured, and one was killed.

The craft had been flying for about five minutes and was about 40 feet above the ground when one of the helicopters lost power. The nose pitched up, and the whole unwieldy structure crashed to the ground. Fire broke out as fuel tanks ruptured.

The accident took place at Lakehurst, N.J., sight of the firey crash of the German zeppelin *Hindenburg* in 1937. The crash of that hydrogen-filled craft killed 36 of the 97 passengers aboard and ended the age of commercial lighter-than-air passenger craft.

CPGilmore
Editor-in-Chief

BOOM YEAR

Pickup trucks have moved off the farm and into the cities and suburbs. For 1987, engineering innovations such as fuel injection and rear-wheel anti-lock brake systems will help make pickups stronger, smoother, safer, and more versatile than ever.

By JACK KEEBLER

The first time I saw the Chevy Silverado SS, it was sitting in a dusty Arizona ghost town dressed in the automotive equivalent of a tuxedo—a $2,000 black and white lacquer paint job. With a Corvette 350 V8, three inches of ground clearance, and Centerline 928 satin-finish aluminum wheels, it obviously wasn't designed to haul tree stumps out of a rutted field.

Weeks later, at General Motors' Milford, Mich., proving ground, I drove the SS with Volker Harhaus, Chevrolet's manager of 90-degree truck engine development. "It'll do zero to sixty in about seven seconds," he said with a smile as he slid in and buckled up. After bumping my head against the cab's power rear window hard enough to scramble my vision, I can safely report that the Silverado SS easily sprints to 60 in just seven seconds. And this pickup rides and handles more like a taut Mercedes sedan than the two-seater from which its power plant was plucked.

Is the dandified Silverado the shape of pickups to come? Not exactly. But it sets the tone. Pickups are changing—fast.

Pickup boom

"Every fifth vehicle on the road has a box rolling along behind it," boasted J. B. York, vice president of Chrysler's truck operations, at the Dodge Dakota pickup introduction recently in South Dakota. The best-selling vehicle in the world last year was the Ford full-size pickup: The company produced 562,507 of the load haulers last year. The other light-truck manufacturers

PEAT MOSS
Southland
Sphagnum
PEAT MOSS

PHOTO BY GREG SHARKO

FOR PICKUPS

are enjoying similar market success.

This surge in buyer interest is keeping truck engineers working to incorporate the technical innovations that until recently were the exclusive province of expensive luxury and sport sedans. Among the new engineering features for 1987 are electronic fuel injection, intake manifold tuning, fuel-efficient transmissions, improved four-wheel-drive systems, anti-lock braking, smooth-ride suspensions, and greatly enhanced corrosion protection.

Also, aware that many of these sales are conquests from competitors' passenger-car models, manufacturers are bringing luxury-car-type comfort and convenience features to light trucks. Luxuriously upholstered seats and interiors, expensive sound systems, electronic climate-control systems, and carlike instrument panels and controls are just some of these features.

And lastly, to make sure that every kind of buyer is satisfied, makers are stuffing every size, style, and payload cranny with special models.

I talked to truck experts while testing '87 pickups on the rocky cliffs above Hawaii's Waimea Canyon, while crossing the badlands of North Dakota, and during tire-smoking handling and acceleration trials at Ford's and Chevrolet's proving grounds in Michigan. Here's what I learned.

Peppier power trains

Modern light-truck power trains for 1987 are receiving engineering upgrades to improve drivability, reduce emissions and fuel consumption, and improve power. The refinements include fuel injection, intake tuning, combustion-chamber tweaks, and improved engine electronics.

"Our customer research reveals that the power train is the backbone of the vehicle," explained Daniel Rivard, Ford's executive director of light-truck product development. "If the engine and transmission are right, the rest of the vehicle is generally right in the eyes of the customer."

Electronic fuel injection (EFI) is a key engineering feature that's helping Ford get power trains right, Rivard says. Fuel injection improves drivability, reduces emissions, and eases cold- and warm-weather starting. Rivard says that EFI may even be more reliable, and eventually less expensive, than a carburetor.

Continued

RACE SERIES
Dodge
DGE·487

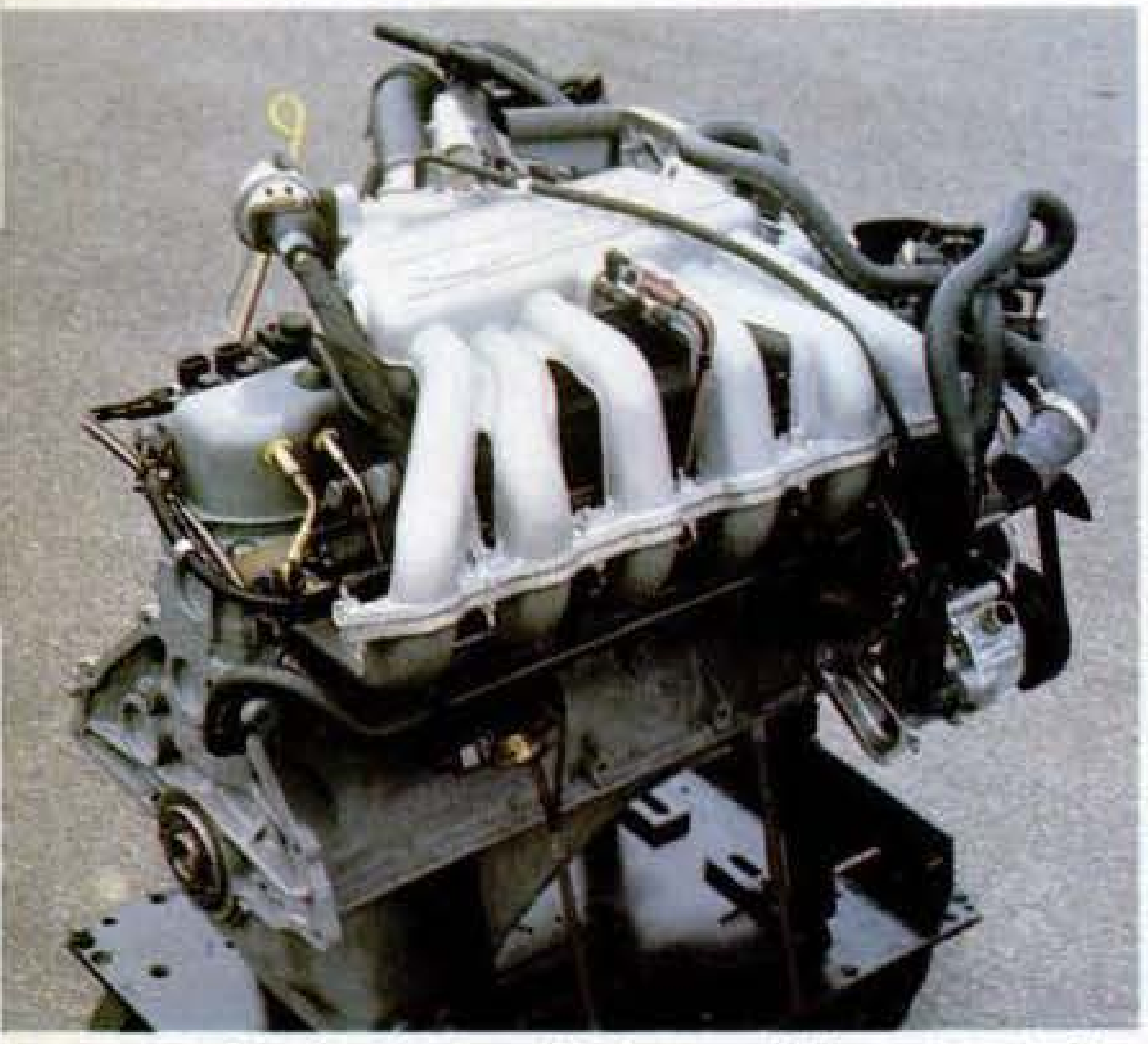


PHOTO BY TOM WILKINSON

Dodge's new Dakota pickup (top) zips through soft gravel. Ford's revamped 4.9-liter in-line six-cylinder engine (above) now breathes through a tuned intake manifold and ingests fuel via a multi-point fuel-injection system. Exhaust exits through a free-flow split-plenum exhaust. Ford's F-series pickup (right) sports halogen headlamps.

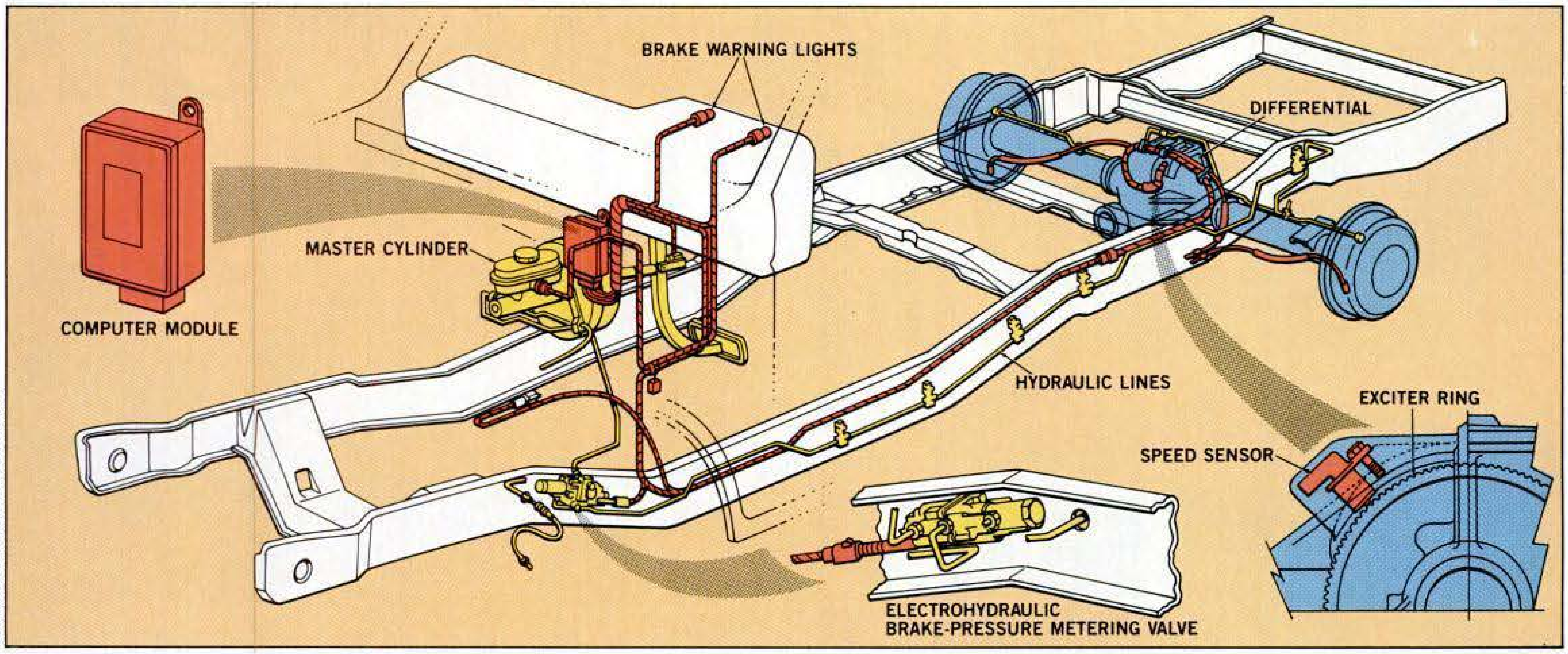
Ford joins Toyota, Nissan, and American Motors Corp. in the switch from carburetors to sophisticated multi-point fuel-injection systems. Chrysler and several import truck companies, however, are sticking with carburetors.

The advantages of multi-point injection were demonstrated by AMC's all-new optional four-liter six for the Comanche pickup. The engine replaces a carburetor-equipped GM 2.8-liter V6. The new engine produces 173 horses with a whopping 220 foot-pounds of torque at 2,500 rpm. AMC claims this engine will push the Comanche to 60 mph in less than 10 seconds. That's a big improvement over the 18.5-second 0-to-60-mph pass PS recorded for a 2.8-liter-equipped Comanche in last February's test.

Although the futuristic Silverado SS has multi-point EFI, Chevrolet engineers told me that single-point, or throttle-body, fuel injection is the best trick for trucks at this time. "We truly believe that throttle-body injection is the most bang for the buck," says Chevy's Harhaus.

Chrysler engineers told me the company doesn't plan to use EFI on trucks until absolutely necessary. One engineer called EFI "exotica" and "gee-whiz stuff," and, in my view, Chrysler pickups aren't suffering without it. I drove the new Dakota, which breathes

ANTI-LOCK BRAKING SYSTEM AT A GLANCE



DRAWING BY RUSSELL VON SAUERS

Rear-wheel anti-lock braking systems consist of a computer module, a wheel-speed sensor, and a brake-pressure metering valve. Sensitive to bed loading and road grip, anti-lock allows pickup pilots to stop with greater control.

through a computer-controlled two-barrel Holley carburetor that seemed smooth even on cold mornings. The truck ran well even at 6,000 feet.

But multi-point injection gives engineers the ability to tune the intake manifold for better breathing and more power. When I opened the hood on the new Ford F-series truck at the Romulus, Mich., proving ground, I thought somebody had dropped a big BMW six into it. Air induction on Ford's venerable 4.9-liter engine is now through a large, beautifully cast aluminum intake manifold that looks as if it would be more at home in a racing car. Ford's power-plant maven, John Huston, told me that the runners and plenum are tuned in length and diameter to improve their ability to swallow air during low-rpm peak-torque operation. Though all the emissions work is not complete, Ford looks for a 16-percent improvement in horsepower and a six-percent improvement in torque over last year's 4.9 with a carburetor.

The 1987 pickup engines are also getting more power, better economy, and lower emissions through advanced combustion-chamber technology. At Chevrolet the standard power plant is called the Vortec 4.3-liter V6. Swirl-port cylinder heads, which create air-fuel mixture turbulence, help this engine produce 155 horsepower and 230 foot-pounds of load-lugging torque. These heads also greatly reduce emissions, according to Chevrolet engineers.

Engineers are also developing new methods to reduce internal engine friction for increased efficiency.

On its five-liter V8, Ford is using new low-tension piston rings that actually seal more tightly to the cylinder wall than the previous rings. Chevrolet's 4.3-liter six will also be more efficient thanks to decreased internal friction. This year Chevy has fitted a roller-lifter valve train. Company experts claim this is worth a three-percent fuel-economy increase.

Transmission tech

Five-speed manual and four-speed automatic transmissions have been helping auto engineers reduce interior noise and meet federal fuel-economy standards for several years. In trucks, the tougher demands of heavy-duty service and lower fuel-economy requirements slowed five-speed manual and four-speed automatic acceptance. Today, however, truck builders are taking a new look at these transmissions. Manufacturers are also making four-wheel-drive transfer cases easier to use for new truck buyers.

Chrysler thought it was so critical to have a five-speed manual for the new Dakota that the company tooled up an entirely new transmission exclusively for the truck—a considerable expense. The five-speed is standard with either the 2.2-liter four or the 3.9-liter V6.

Four-speed automatics are also an expensive feature for truck builders—and owners. But because they're easier to operate, offer more intermediate gears for better acceleration, and provide an overdrive fourth gear for fuel efficiency and quiet operation, four-speed automatics are showing up

[Continued on page 101]

PHOTO BY BARRY PENFOUND

A spy photographer zooms in on an anti-lock-equipped 1988 Chevrolet pickup truck. Muscle is provided by fuel-injection V8s as large as 7.4 liters.

Chrysler, Ford, GM shift into high

Flashy coupes and convertibles are grabbing headlines once again. But a careful look under the skins of the 1987 domestic cars reveals improvements in engines, drive trains, and suspension systems that will help make the Big Three more competitive in quality and cost with the best from Europe and Japan.

By TOM WILKINSON
Research by Dan McCosh and Tom Wilkinson

Hardware talks. And many car buyers who can't tell a crankshaft from a window crank understand what it says. Engines idle smoothly, doors close with a click, and seats are comfortable for hours on end because the car maker paid attention to things mechanical. And when a Honda or Mercedes-Benz whispers like fine machinery, buyers seem eager to listen.

Detroit has been listening too. And in the 1987 models you can see the strategies the Big Three are pursuing in their race with Europe and Japan. General Motors is focusing some of its engineering might on its low-cost family cars. Chrysler continues to spin off new models from its existing chassis, trying to consolidate its position as the low-cost domestic producer. And Ford, after the wildly successful introduction of its European-style Taurus, challenges the Japanese in the four-wheel-drive sedan market. The highlights follow.

Though Chrysler is in the midst of restyling its entire range of cars, most will continue to share the front-drive chassis first introduced in the K-car (Aries and Reliant).

The Shadow and Sundance, Chrysler's new subcompacts, kicked off the restyling cycle earlier this year. Now comes the flashy, mid-priced LeBaron coupe, probably the best-looking Chrysler in years. Later in 1987, Chrysler will offer a K-car chassis in evening clothes—the high-priced Q-coupe, which will be built jointly with Maserati.

GM also will try its luck with two high-price two-seaters, the Cadillac Allanté and Buick Reatta. Perhaps taking a lesson from Chrysler, GM also will base both on an existing chassis, one currently used for the Riviera, Toronado, and Eldorado. The Allanté seems certain to make the 1987 model year. The Reatta may be delayed until 1988.

There is also big news under the skin of the 1987 domestics. GM has redesigned two of its high-volume engines. Both Chrysler and GM have turned to Germany for a good five-speed transaxle. And Ford takes on Subaru with a four-wheel-drive sedan.

GM, which has occasionally gone too far in trying to slash production costs of its basic hardware, appears to be making an about face. Chevrolet has redesigned two of its bread-and-butter engines—the two-liter push-rod four

Continued

DETROIT FOR '87

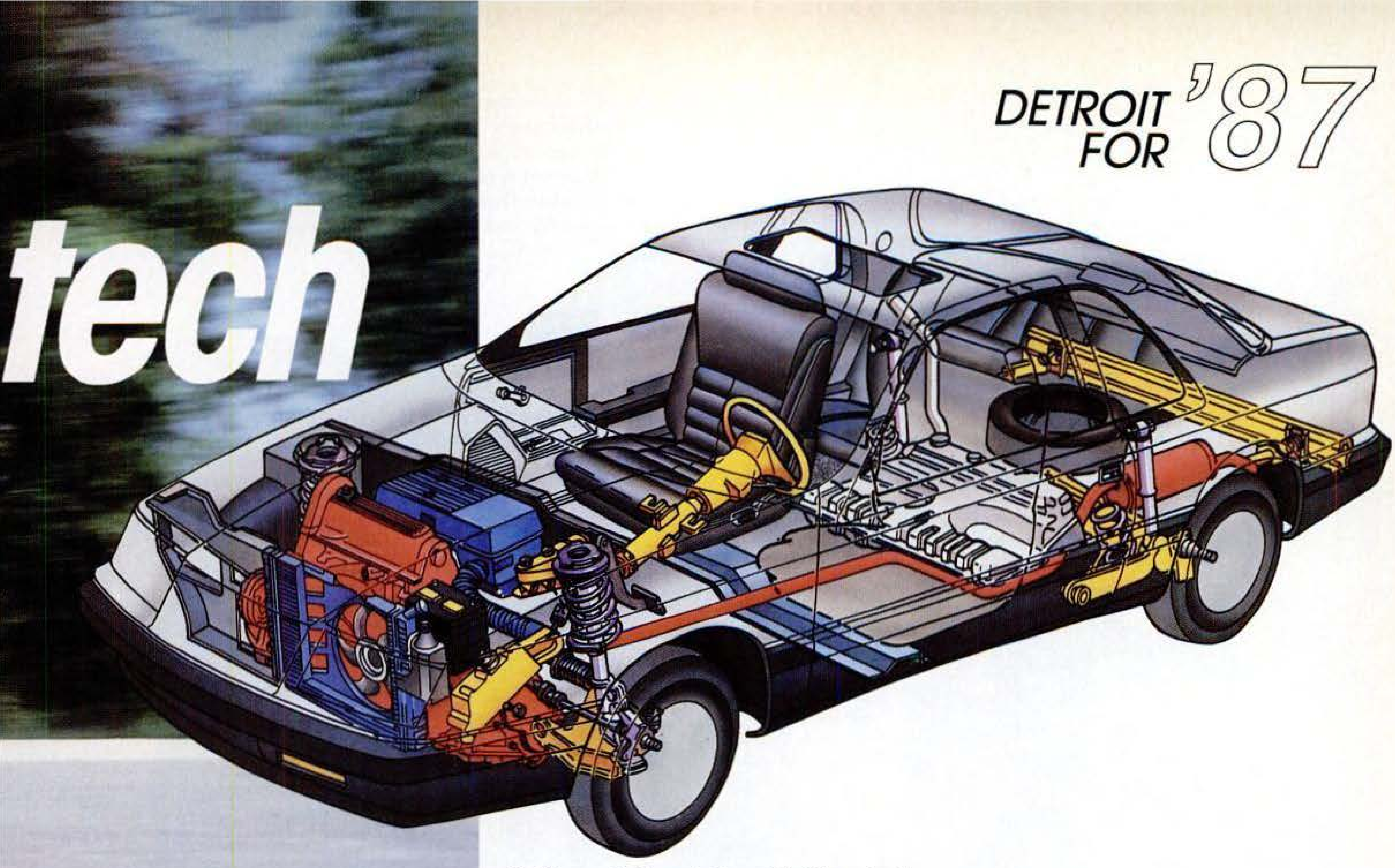


PHOTO BY THE AUTHOR

LeBaron (left and above) is Chrysler's familiar front-drive chassis dolled up with sleek convertible and coupe bodies. Both use a 2.5-liter four with balance shafts; a 2.2-liter turbo engine is optional. Unlike many convertibles, which are assembled by specialty builders, the LeBaron rag top (due in the spring) will roll off the same assembly line as the coupe.

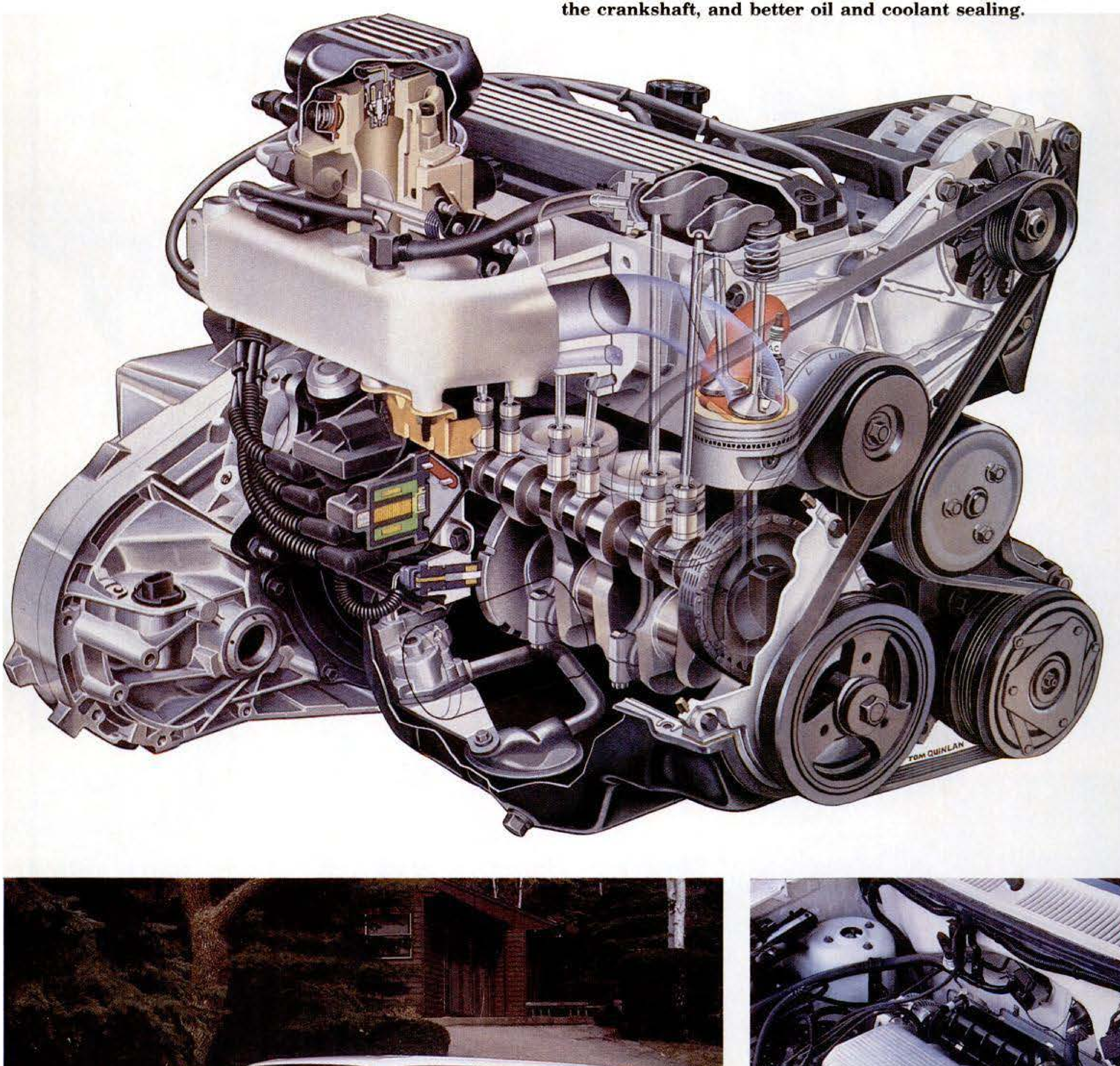
Pontiac Bonneville (above) is similar mechanically to the current Buick LeSabre and Oldsmobile 88. No surprises here, just a smooth family sedan.

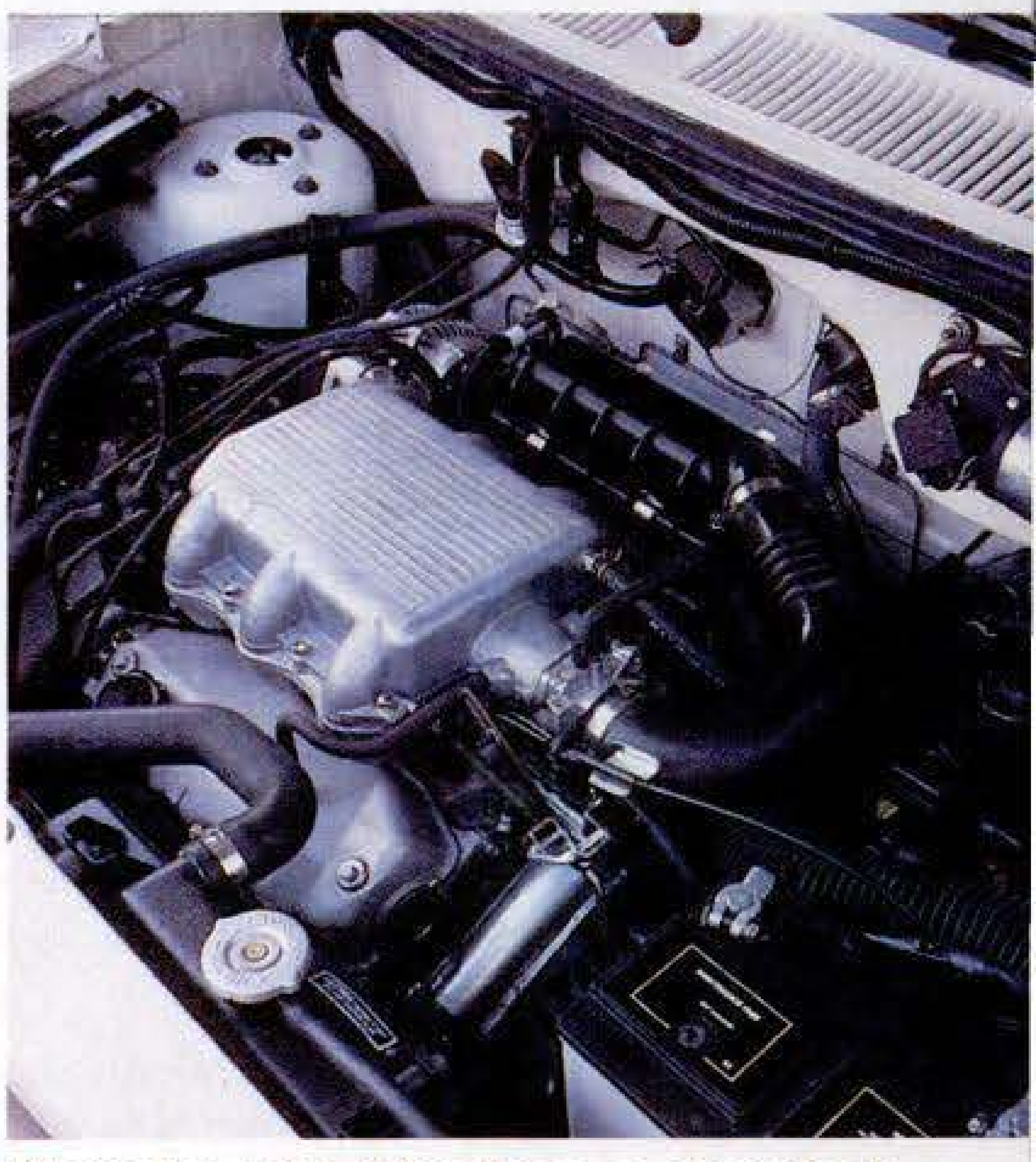
PHOTO BY THE AUTHOR

PHOTO BY THE AUTHOR

Other arrivals during 1987 will include the as-yet-unnamed Chrysler-Maserati (top right), shown with its removable hardtop in place. Cadillac woos the carriage trade with the Allanté (above right). The car's body will be built in Italy and shipped by air to Detroit for final assembly. Chevy's high-volume compacts, the Beretta (right) and its twin, the Corsica sedan, will arrive mid-year. Both use Chevrolet's revised two-liter four and 2.8-liter V6.

Chevrolet's two-liter four (below) and 2.8-liter V6 reflect Detroit's rediscovery of basic engineering. Improvements include new cast aluminum cylinder heads, revised combustion chambers, improved fuel-injection systems, distributorless ignition that reads timing directly off the center of the crankshaft, and better oil and coolant sealing.





Chrysler will introduce a stretched mini-van in early '87 (left), along with a much-needed Mitsubishi-built V6 (above). The compact three-liter has a 60° V-angle, belt-driven overhead camshafts, and port fuel injection.

and 2.8-liter V6—that are used in *millions* of GM family cars. I can only hope the sample engines I saw torn apart and spread across a series of tables were representative—the quality of the castings and the attention to detail were among the best I've seen anywhere.

The 2.8-liter V6 also will be the first engine to feature GM's new Multec port fuel injector. It's a drop-in replacement for the Bosch injector used by every car maker from Audi to Pontiac, but it meters fuel with a simple ball valve rather than a precisely machined pintle. Company engineers say it is "significantly cheaper" to make than the Bosch design, and is also more tolerant of poor quality gasoline [PS cover story, March].

The new Chevy engines are lighter and more powerful than their predecessors, and Don Runkle, chief engineer, expects them to be more reliable as well. Chevy's three biggest warranty problems have been ignition timing, carburetor adjustments, and drive belts, says Runkle. Both new engines feature distributorless ignition systems that never need to be timed. There are no carburetors. And both employ a serpentine belt with an automatic tensioner.

Chrysler, in search of still more power from its basic 2.2-liter engine, has added an intercooler to the optional turbocharger and called the result Turbo II. For 1987, the engine will power the Daytona Shelby Z. I found the engine's 174 horsepower, when combined with Daytona's stiff front-drive chassis, made driving on Chrysler's bumpy test track a bit too thrilling. And the big four is still harsh and noisy when pushed, no substitute for a good V6.

Some Chryslers will finally get that much-needed V6, a three-liter engine that Mitsubishi will build for the mini-vans. The overhead-cam fuel-injection engine will eventually replace all remaining 2.6-liter fours, and may also power the full-size front-drive Chrysler sedan due in the spring.

To handle the torque of high-output engines, GM and Chrysler will install five-speed manual transaxles built with technology acquired from Getrag of Germany. GM will actually manufacture its own Getrag-designed five-speeds, while Chrysler will buy gear clusters directly from Getrag for Dodge Daytonas equipped with the Turbo II engine.

Ford has moved the turbocharged, intercooled 2.3-liter engine from the defunct SVO Mustang into the Thunderbird Turbo Coupe. Also new are electronically controlled shocks that soften damping during normal driving; I found they eliminate much of the harshness that made the 1986 Turbo Coupe ride like Bill Elliott's NASCAR T-bird.

Ford also has been busy in the engine lab. GM, tired of having Camaro and Firebird owners left in the dust by Mustang GTs, is dropping the 5.7-liter Corvette engine into both coupes. So Ford counters with a 230-horsepower version of its five-liter V8. Ford engineers told me a low-restriction intake manifold yielded most of the power increase.

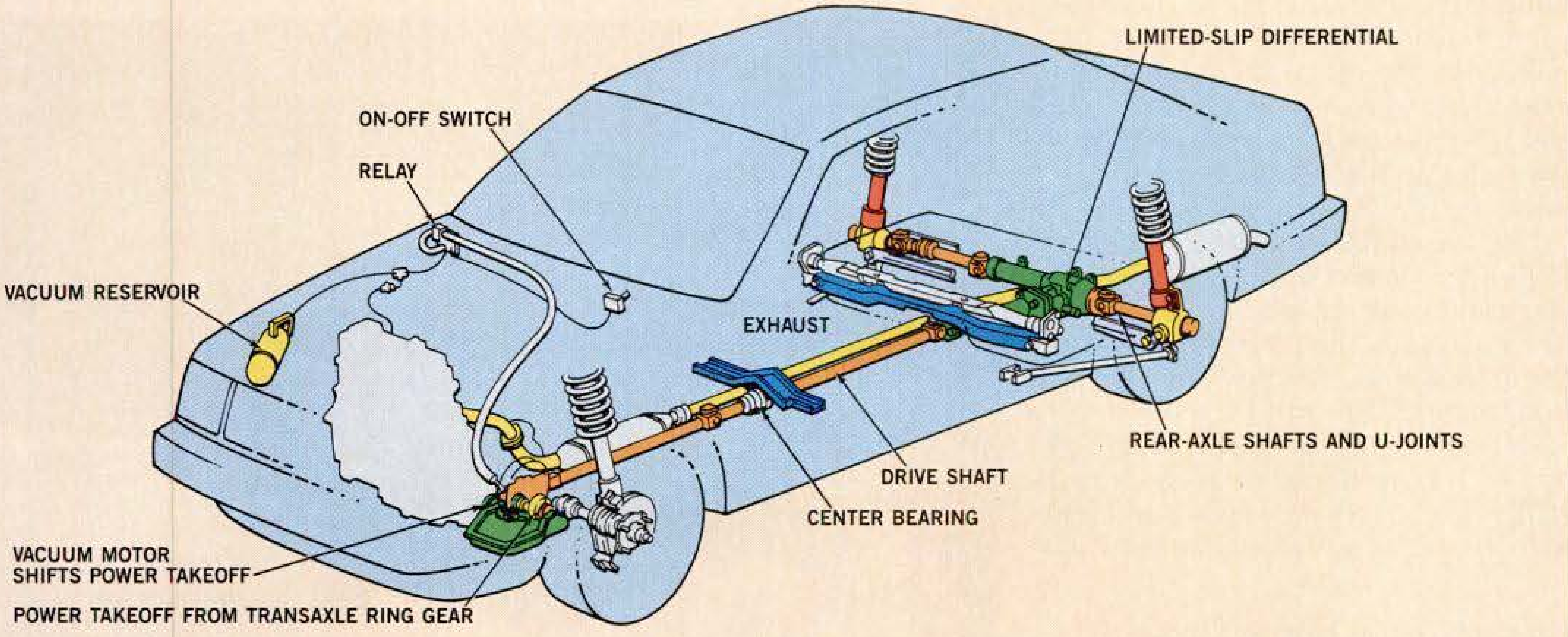
For folks up north, Ford will build a part-time four-wheel-drive system for the Tempo and Topaz. The cars' independent rear suspension is retained, and ride height is just half an inch higher than in the front-drives. The June weather meant there wasn't much snow at Ford's Michigan proving ground. But there was a steep, smooth, grassy hill, and I found the four-wheel-drive Tempo could chug right up the side of it.

Finally, Ford has upgraded the front brakes on the Mustang, Thunderbird, and Cougar by installing larger vented discs from the Continental. The braking power of Ford products has often come under fire in PS car tests, so it's a change I'm happy to see.

PHOTO BY THE AUTHOR

Corvette will get an electronic tire-pressure monitor. Transmitters in each wheel signal a receiver if pressure drops below a set level.

Inside Ford's four-wheel-drive sedans



DRAWING BY RUSSELL VON SAUERS

Part-time four-wheel drive for the Tempo and Topaz takes power from the ring gear in the automatic transaxle and routes it to a differential in the rear axle. A switch on the instrument panel engages the system, which adds about 142 lbs. and some $1,000 to the current car. Adding four-wheel drive required no floor-pan modification.

Video photography
—the electronic revolution continues

Slip a two-inch magnetic disk into Canon's new electronic reflex camera and capture 50 still-video images. You can display them on many TVs or record them with an ink-jet printer. And computerized transceivers can send the color pictures over telephone lines.

By JOHN FREE

A curious whirring sound begins as I partially depress the fat gray exposure button on Canon's new RC-701. This camera looks and operates like a 35-mm single-lens reflex. "That's the video-floppy disk spooling up to 3,600 rpm," says David Metz, technical manager at Canon U.S.A.'s Lake Success, N.Y., headquarters. "You don't want it spinning and draining the battery when you're not taking pictures."

I push the plastic button all the way down. There's a familiar click from the camera shutter. But then any resemblance to ordinary picture taking vanishes: I open the camera back, pull out a cracker-size magnetic disk, and slide the disk into a compact recorder-player on a nearby table. Within seconds, my color snapshot flashes onto a TV screen. Next, Metz feeds the picture through a cable to a small ink-jet printer; minutes later the printer spits out a three-by-five-inch color print. He then pops the disk into another new machine, a transceiver, demonstrating how my picture can be transmitted over phone lines anywhere in the world within three minutes.

It's clear that Canon's extraordinary still-video system opens a new era in electronic photography, or "imaging," as Canon calls the process. Instead of the permanent chemical changes of film, pictures are captured electronically and stored on erasable magnetic disks. The new hardware is costly, and still-video images are crude compared with conventional photography. Nevertheless, Canon hopes customers will value the speed and flexibility. "Newspapers, magazines, and news-photo agencies are the most likely immediate users," says Fujio Mitarai, Canon's president.

While Canon is first with a complete system, Sony Corp. of America is also in the race, and others will follow. At a recent show in Atlanta, Ga., I saw a demonstration of Sony's new still-video system. Sony has hardware similar to Canon's but won't have a still-video camera until next year.

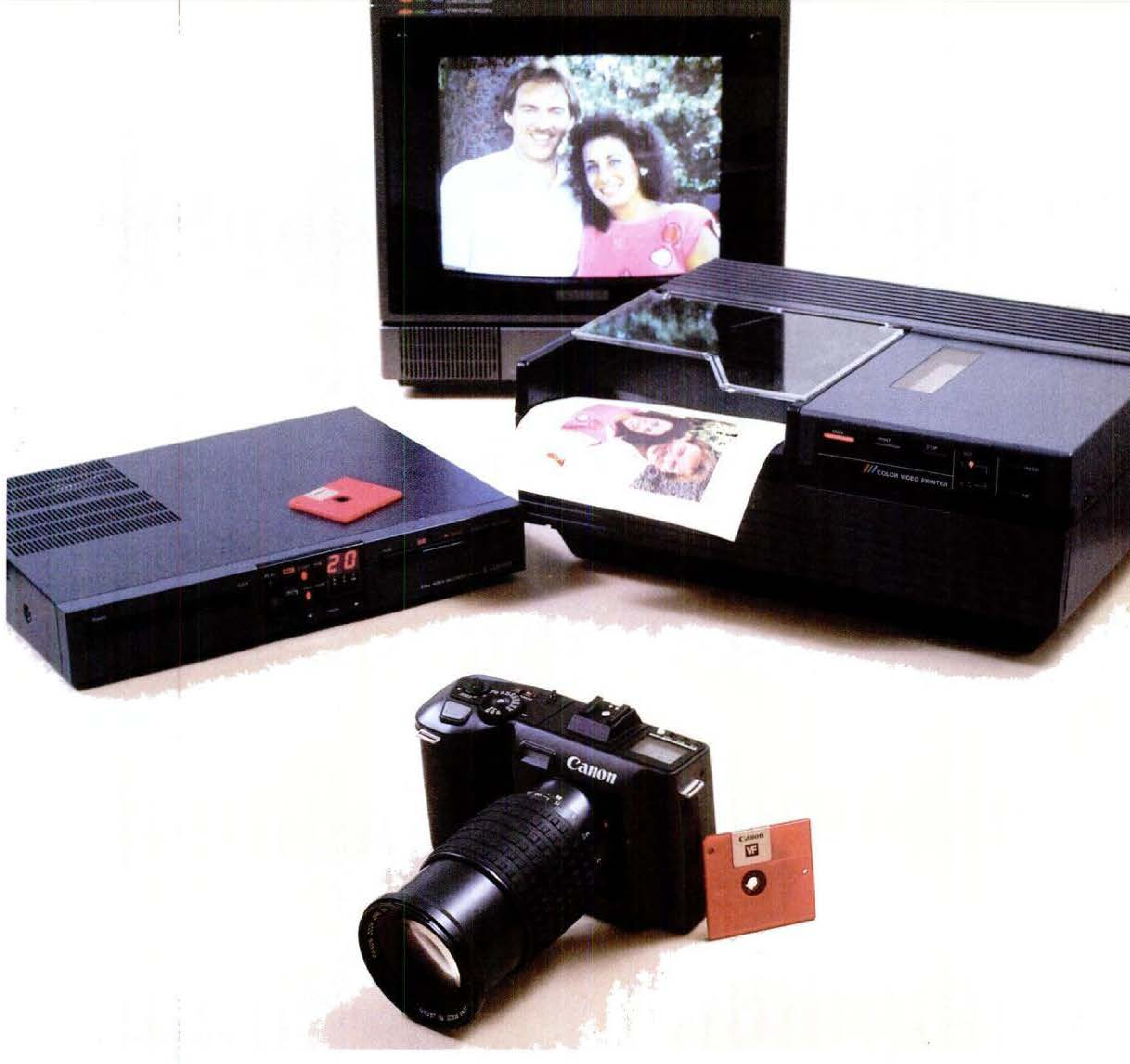
Ironically, Sony's prototype Mavica still camera shown five years ago [PS, Dec. '81] shocked Canon, a film-camera company, into a crash electronic-photography program. Says Canon's director of photo products, Masahiro Tanaka: "We were about to face competition from the huge electronics companies. Sony, in a sense, had been a warning."

But a key component in electronic photography, the solid-state image sensor that converts light into electricity, has delayed Sony's camera entry. The 1981 Mavica used a charge-coupled-device (CCD) image chip with an array of some 280,000 individual sensing elements. Sony felt this didn't provide enough picture elements (pixels) for industrial or consumer use. Next year, from its Park Ridge, N.J., division, Sony may roll out its camera with a 700,000-pixel sensor chip. Higher pixel density means sharper, finer-detail images. Conventional 35-mm photos have 10 million to 20 million pixels.

Canon's first still-video camera has a 380,000-pixel CCD made by Texas Instruments. At Canon's big headquarters building, Metz twists a $695 zoom lens off the $2,595 camera body, showing me a flip-up mirror that hides the CCD. The camera, he explains, has the capability of recording 50 *field* im-

[*Continued on page 98*]

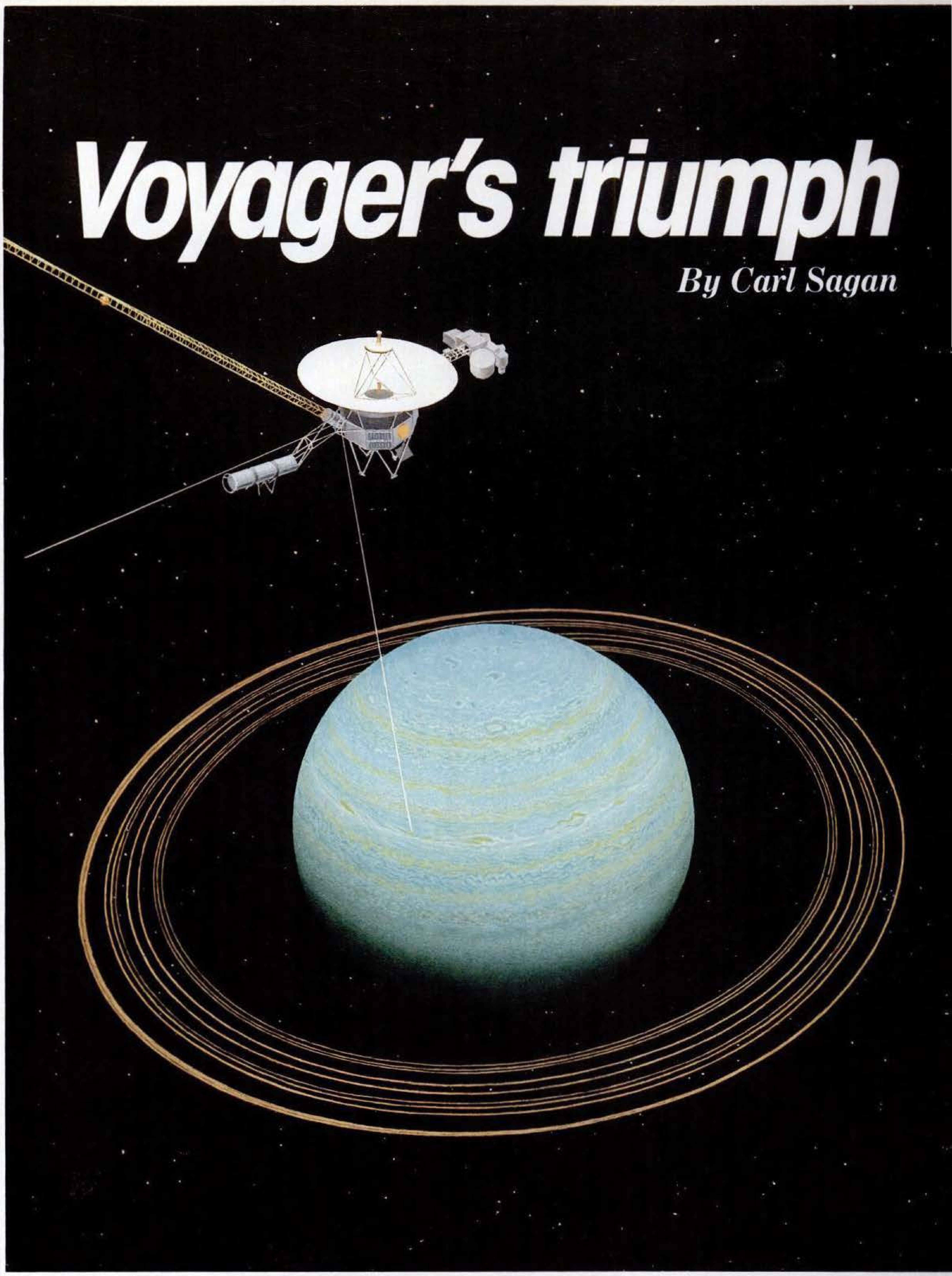
Laser videodisc recorder (near right) from Sony captures 8,000 still-video images on a 12-in. disc. Adjacent portrait (facing page) is from Sony thermal-transfer printer; image is from a broadcast-quality videotape machine.



Canon still-video camera (above) invisibly logs date, time, and exposure data with each of 50 images captured on a magnetic disk. Disk, removed from camera back, is played back on a video recorder (top, left) hooked to a TV and an ink-jet printer (right) that provides two print sizes. Versatile recorder is operated with a remote control.

Voyager's triumph

By Carl Sagan



A noted scientist tells the little-known story of the remarkable feats of the Voyager engineers, a dedicated band who repeatedly overcame technical adversity to ensure the success of these historic expeditions to the outer solar system.

Carl Sagan is Director, Laboratory for Planetary Studies, Cornell University, and, since 1970, a member of the Voyager Imaging Science Team. His Cosmos: A Special Edition *is televised this fall.*

On Jan. 25, 1986, the Voyager 2 robot probe entered the Uranus system and reported a procession of wonders. The encounter lasted only a few hours, but the data faithfully relayed back to Earth have revolutionized our knowledge of the aquamarine planet, its more than 15 moons, its pitch black rings, and its belt of trapped high-energy charged particles. Voyager 2 and its companion, Voyager 1, have done this before. At Jupiter, in 1979, they braved a dose of trapped charged particles 1,000 times what it takes to kill a human being [PS, July '79]; and in all that radiation they discovered the rings of the largest planet, the first active volcanoes outside Earth, and a possible underground ocean on an airless world—among a few hundred other major findings. At Saturn, in 1980 and 1981, the two spacecraft survived a pummeling by tiny icy particles as they plummeted through previously unknown rings; and there they discovered not a few, but thousands of Saturnian rings, icy moons recently melted through unknown causes, and a large world with an ocean of liquid hydrocarbons surmounted by clouds of organic matter [PS, March '81]. These spacecraft have returned to Earth four trillion bits of information, the equivalent of about 100,000 encyclopedia volumes.

Because we are stuck on Earth, we are forced to peer at distant worlds through an ocean of distorting air. It is easy to see why our spacecraft have revolutionized the study of the solar system: We ascend to the stark clarity of the vacuum of space, and there approach our objectives, flying past them or orbiting them or landing on their surfaces. These nearby worlds have much to teach us about our own, and they will be—unless we are so foolish as to destroy ourselves—as familiar to our descendents as the neighboring states are to those who live in America today.

Voyager and its brethren are prodigies of human inventiveness. Just before Voyager 2 was to encounter the Uranus system, the mission design had scheduled a final course correction, a short firing of the on-board propulsion system to position Voyager correctly as it flew among the moving moons. But the course correction proved unnecessary. The spacecraft was already within 200 kilometers of its designed trajectory after a voyage along an arcing path five billion kilometers in length. This is roughly the equivalent of throwing a pin through the eye of a needle 50 kilometers away, or firing your target pistol in New York and hitting the bull's eye in Dallas.

The lodes of planetary treasure were transmitted back to Earth by the radio antenna aboard Voyager; but Earth is so far away that by the time the signal was gathered in by radiotelescopes on our planet, the received power was only 10^{-16} watts (fifteen zeros after the decimal point). Comparing this weak signal with the power emitted by an ordinary reading lamp is like comparing the width of an atom with the distance between Earth and the moon. (Incidentally, the first photograph ever taken of Earth and the moon together in space was acquired by one of the Voyager spacecraft.)

Celebrating the ship builders

We tend to hear much about the splendors returned, and very little about the ships that brought them, or the shipwrights. It has always been that way. Our history books do not tell us much about the builders of the Niña, Pinta, and Santa Maria, or even the principle of the caravel. Despite ample precedent, it is a clear injustice: The Voyager engineering team and its accomplishments deserve to be much more widely known.

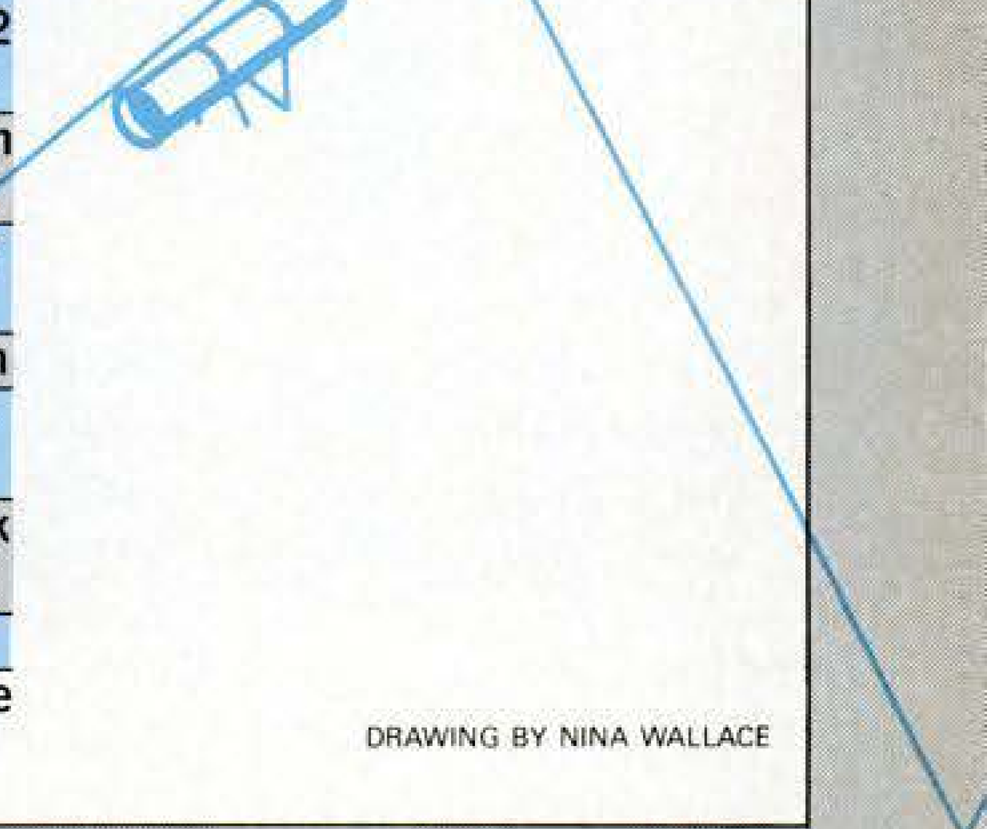
The Voyager spacecraft were designed and assembled, and are operated by the Jet Propulsion Laboratory (JPL) of the National Aeronautics and Space Administration in Pasadena, Calif. The mission was conceived during the

Continued

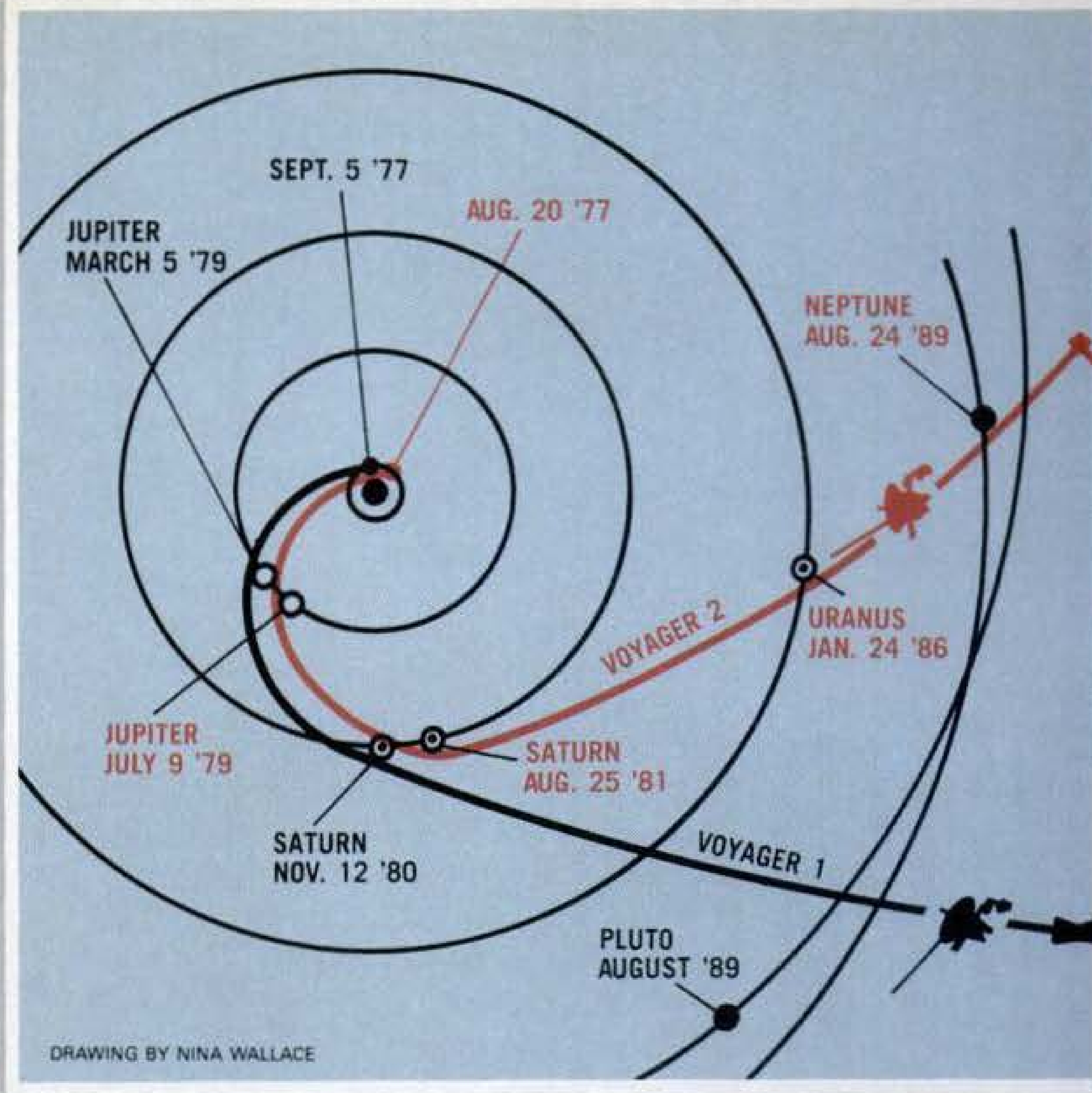
The Voyager engineers

NAME	TITLE	ROLE IN VOYAGER PROBLEM-SOLVING
Donald L. Gray	Navigation team chief	Unprecedented navigation
Douglas G. Griffith	Manager, flight operations office	Chief operations implementer
Charles E. Kohlhase	Manager, mission planning office	Conservator of consumables and provider of entire mission design framework
Boyd D. Madsen	Telecommunications engineer	Master of the black arts needed to communicate with the impaired Voyager 2 backup receiver
Carl A. Marchetto	Mechanical engineer	Conductor of 3½-year-long scan-platform actuator test program
Howard Marderness	Spacecraft team chief	Image smear reduction, and guardian of spacecraft's health
William I. McLaughlin	Manager, flight engineering office	Analysis of failed actuator and usage plan
Richard J. Rice	Programmer, flight data system	New on-board software for image data compression
Robertson Stevens	Deep-space network chief engineer	Multiple antenna arraying to receive weak spacecraft signal
Donna Wolff	Staff engineer	Statistical analysis, actuator failure test

This list is highly incomplete. Voyager engineering is, at its core, a team effort; only a few of the people involved can be listed here



DRAWING BY NINA WALLACE



DRAWING BY NINA WALLACE

Voyager 1 and 2 both encountered Jupiter in 1979 and Saturn in 1980–'81. Swing-by trajectories utilize the gravitational fields of inner Jovian planets to reach outer ones. Voyager 2 encountered Uranus on Jan. 25, 1986, and is scheduled to encounter Neptune in late summer 1989. Voyager 1 will not encounter any other known planets. Last January, Voyager 2 radioed back pictures of the Uranian moons Oberon (photo 1) and Umbriel (photo 2). The surfaces of all five big moons of Uranus contain copious amounts of water ice along with a dark coloring agent, probably complex organic matter.

late 1960s, first funded in 1972, but was not approved in its present form (which includes encounters at Uranus and Neptune) until after the 1979 Jupiter flyby. The two spacecraft were launched in late summer and early fall 1977 by a non-reusable Titan/Centaur booster configuration at Cape Canaveral, Fla. Weighing about a ton, a Voyager would fill a good-sized living room. Each spacecraft draws about 400 watts of power—considerably less than an average American home—from a generator that converts radioactive plutonium into electricity. The instrument that measures interplanetary magnetic fields is so sensitive that the flow of electricity through the innards of the spacecraft would generate spurious signals. As a result, this instrument is placed at the end of a long boom stretching out from the spacecraft. With other projections, it gives Voyager a slightly porcupine appearance. Two cameras, infrared and ultraviolet spectrometers, and an instrument called the photopolarimeter are on a scan platform; the platform swivels so these instruments can point toward a target world. The spacecraft antenna must know where Earth is if the transmitted data are to be received back home. The spacecraft also needs to know where the sun is and at least one bright star, so it can orient itself in three dimensions and point properly toward any passing world. It does no good to be able to return pictures over billions of miles if you can't point the camera.

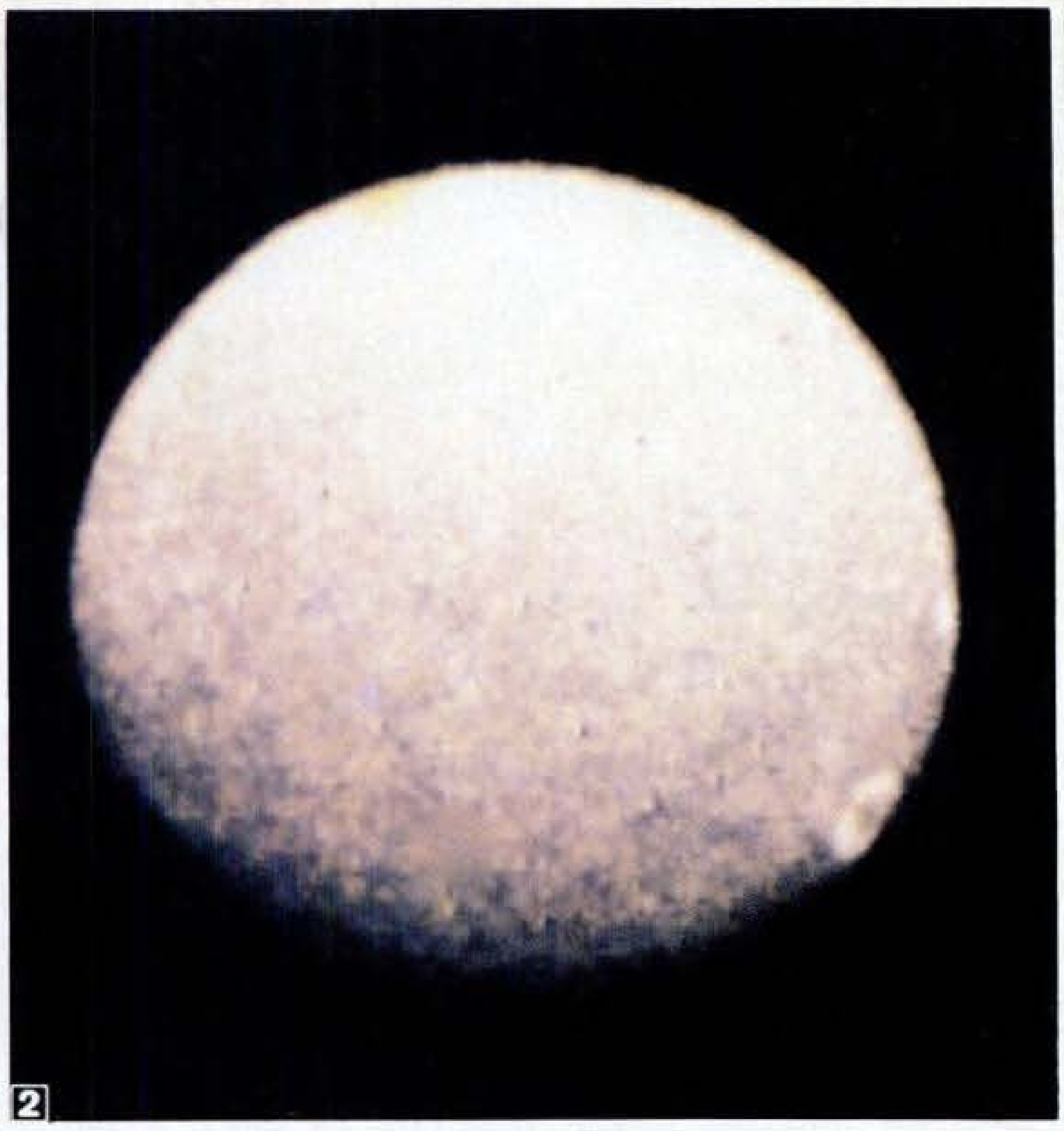
On-orbit repairs

Each spacecraft costs about as much as a single modern strategic bomber. But unlike bombers, Voyager cannot, once launched, be returned to the hangar for repairs. As a result, the spacecraft's computers and electronics are designed redundantly. And when Voyager finds itself in trouble, the computers use branched contingency tree logic to work out the appropriate course of action. As the spacecraft journeys increasingly far from Earth, the round-trip light (and radio) travel time also increases, approaching six hours by the time Voyager is at the distance of Uranus. Thus, in case of an emergency, the spacecraft needs to know how to put itself in a safe standby mode while awaiting instructions from Earth. As the spacecraft ages, more and more failures are expected, both in its mechanical parts and its computer system, although there is as yet no sign of a serious memory deterioration, some robot Alzheimer's disease. When an unexpected failure occurs, special teams of engineers— some of whom have been with the Voyager program since its inception—are assigned to "work" the problem. They will study the underlying basic science and draw upon their previous experience with the failed subsystems. They may do experiments with identical Voyager spacecraft equipment that was never launched, or even manufacture a large number of components of the sort that failed in order to gain some statistical understanding of the failure mode.

In April 1978, almost eight months after launch, an omitted ground command caused Voyager 2's on-board computer to switch from the prime radio receiver to its backup. During the next ground transmission to the spacecraft, the receiver refused to lock onto the signal from Earth. A component called a tracking loop capacitor had failed. After seven days in which Voyager 2 was out of contact, its fault protection software commanded the backup receiver to be switched off and the prime receiver to be switched back on. But, mysteriously, the prime receiver failed moments later. It never recovered. Voyager 2 was now fundamentally imperiled. Although the primary receiver had failed, the on-board computer commanded the spacecraft to use it. There was no way for the controllers on Earth to command Voyager to revert to the backup receiver. Even worse, the backup receiver would be unable to receive the commands from Earth—because of the failed capacitor. Finally, after a week of command silence, the computer was programmed to switch automatically between receivers. And during that week's time the JPL engineers designed an innovative command frequency control procedure to make a few essential commands comprehensible to the damaged backup receiver.

This meant the engineers were able to communicate, at least a little bit, with the spacecraft. Unfortunately the backup receiver now turned giddy, becoming extremely sensitive to the stray heat dumped when various components of the spacecraft were powered up or down. Over the following months the JPL engineers designed and conducted a series of tests that let them thoroughly understand the thermal consequences of most operational modes of the spacecraft on its ability to receive commands from Earth. The backup-receiver problem was entirely circumvented. It was this backup receiver that acquired all the commands from Earth on how to gather data in the Jupiter, Saturn, and Uranus systems. The engineers had saved the mission. (But to be on the safe side, during most of Voyager's subsequent flight there is in residence in the onboard computers a nominal data-taking sequence for the next planet to be encountered.)

1



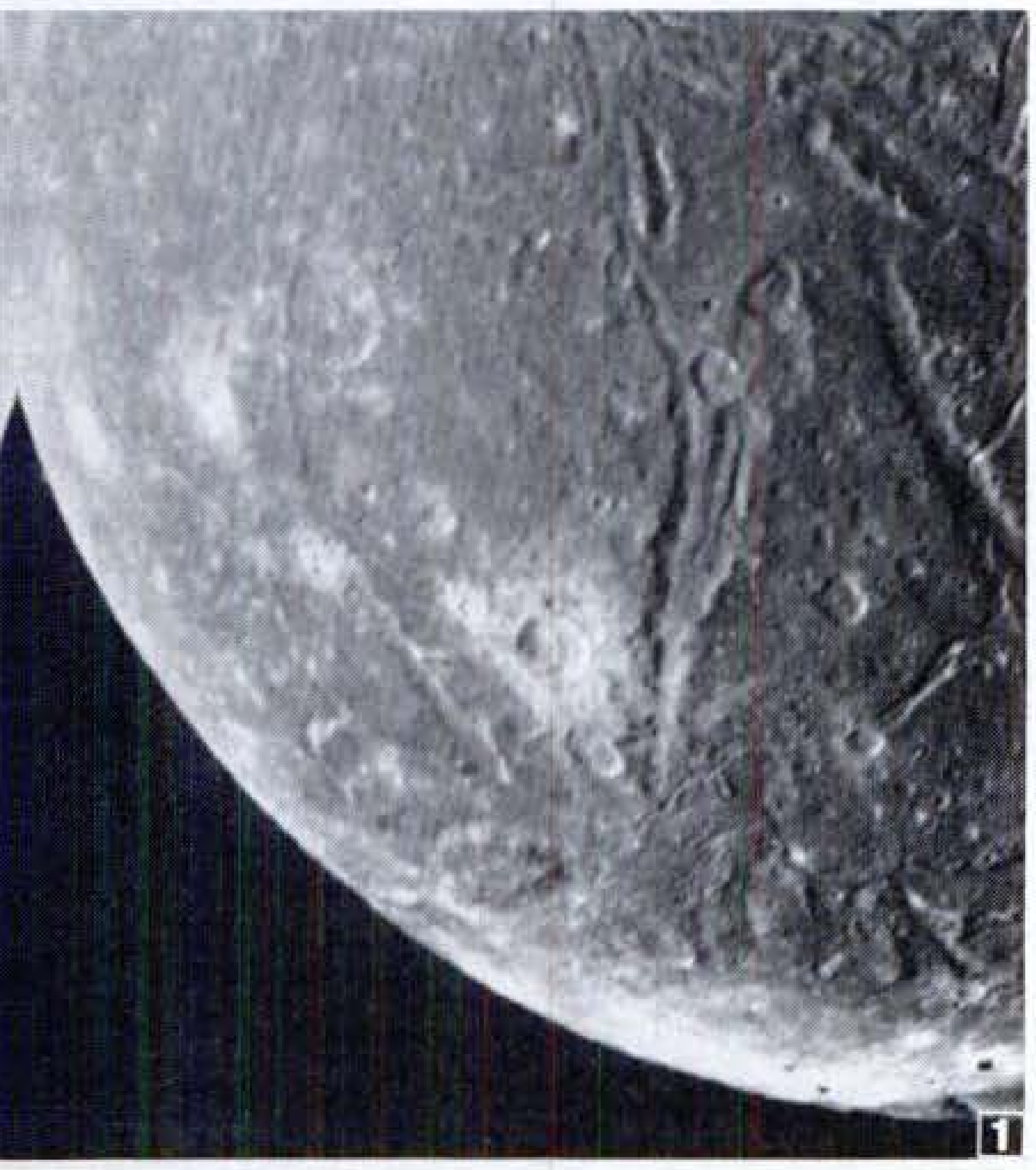
2

Another heart-wrenching failure occurred just after Voyager 2 emerged from behind Saturn after its closest approach to the planet in August 1981. The scan platform had been moving rapidly in the azimuth direction—quickly pointing here and there among the rings, moons, and the planet itself during the time of closest approach. Suddenly, the platform jammed. A stuck scan platform obviously implies a severe reduction in future pictures and other key data. The scan platform is driven by gear trains called actuators, so first the JPL engineers ran an identical copy of the flight actuator in a simulated mission. The ground actuator failed after 348 revolutions; the actuator on the spacecraft had failed after 352 revolutions. The problem turned out to be a lubrication failure. Plainly, it would be impossible to overtake Voyager with an oil can. The engineers wondered whether it *would* be possible to restart the failed actuator by alternately heating and cooling it, so that the thermal stresses would cause the components of the actuator to expand and contract at different rates and un-jam the system. After gaining experience with specially manufactured actuators on the ground, the engineers jubilantly found that they were able to use this procedure to start the scan platform up again in space. More than this, they devised techniques to diagnose any imminent actuator failure early enough to work around the problem. Voyager 2's scan platform worked perfectly in the Uranus system. The engineers had saved the day again.

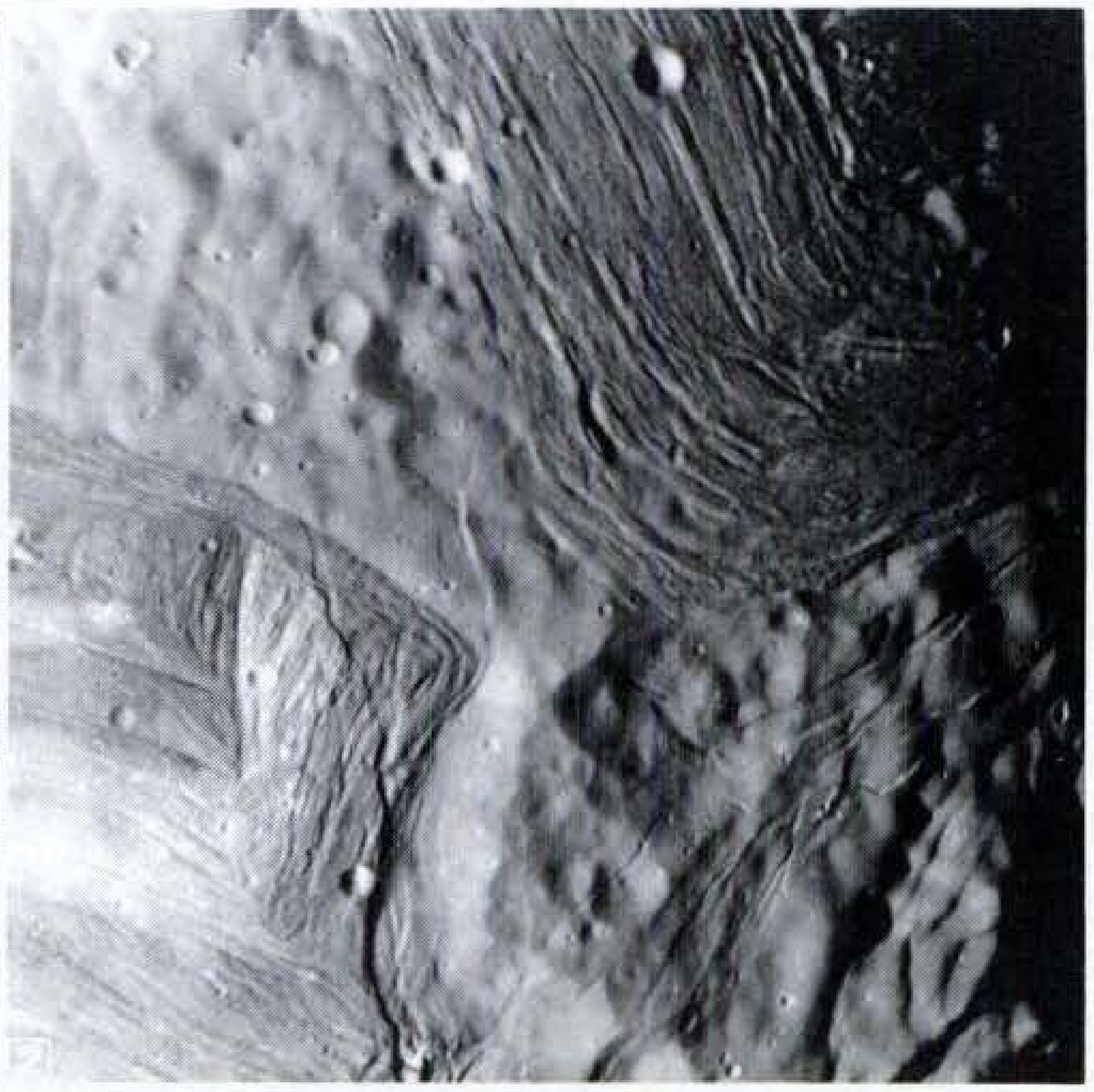
Ingenious solutions

Voyager 1 and 2 were designed to explore the Jupiter and Saturn systems only. It is true that their trajectories would carry them to Uranus and Neptune, but officially these planets were never contemplated as targets for Voyager exploration: The spacecraft was not supposed to last that long. Because of trajectory requirements in the Sat-

[Continued on page 116]

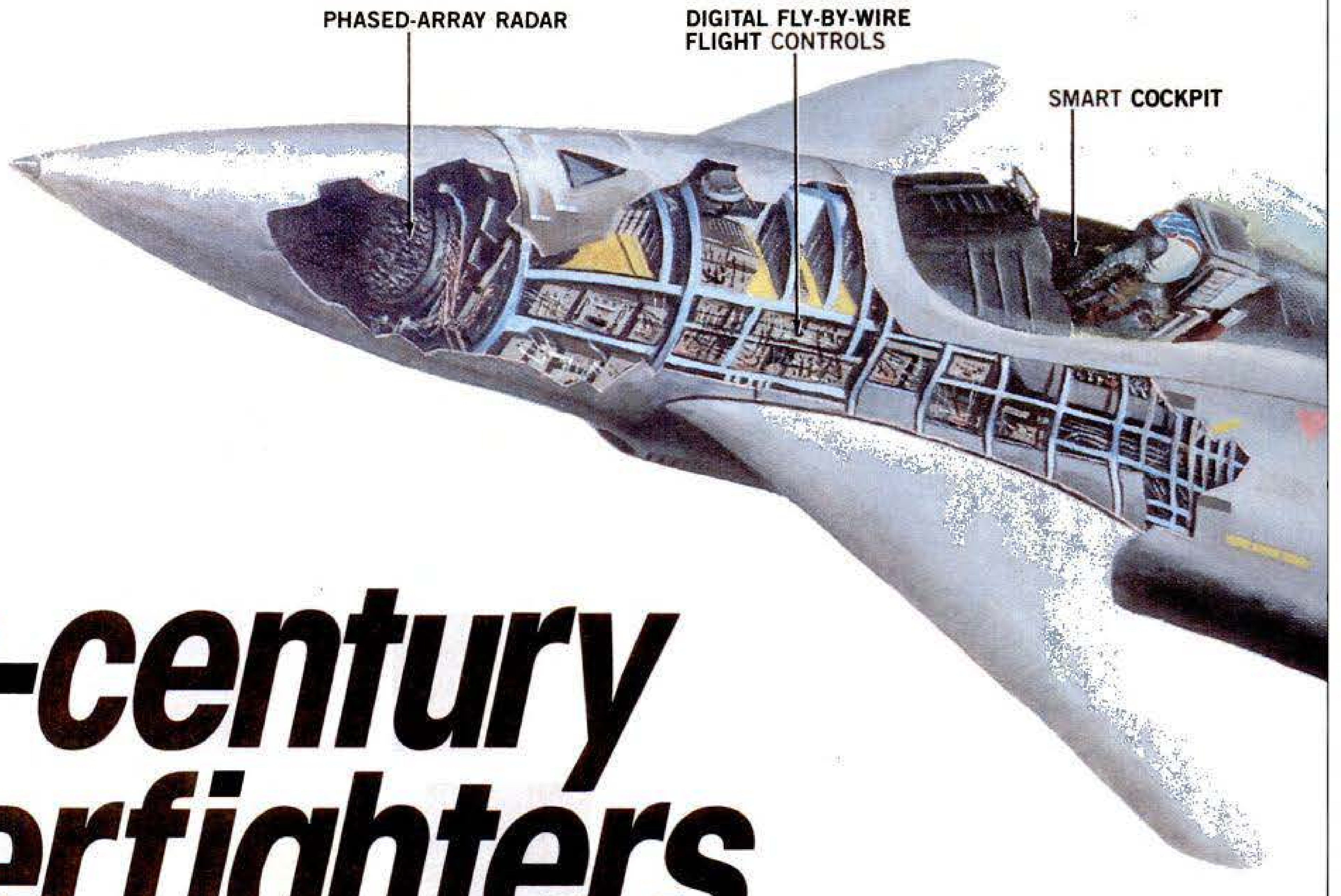


1



2

In this high-resolution Voyager 2 image of the Uranian moon Ariel (photo 1), the surface is seen to be broken up by impact craters and long grooves, probably of tectonic origin. Smooth patches indicate the deposition over time of an unknown material. Underneath the cometary impact craters of Miranda (photo 2)—the innermost of the large Uranian moons—are landforms indicating a complex geological history.



21st-century superfighters

Dramatic leaps in aerospace technology have occurred since the F-15—the Air Force's hottest fighter—was designed in 1969. The new generation of fighters will be faster, more agile, and harder to detect than today's warbirds. Lightweight composites, smart avionics, wings that change shape, and powerful engines will make them swift and deadly performers.

By STUART F. BROWN
Cutaway painting by Barry Bichler

Cruising at supersonic speed into the night, the veteran fighter pilot is on routine patrol. Stars twinkle in the indigo sky. The heavens seem peaceful. Suddenly, the radar display on the fighter's instrument panel shows three, then seven yellow question marks approaching from the east 150 miles out. "Bad guys or good guys?" the pilot wonders, glancing at the cockpit display to confirm that his detection sensors are working properly.

Then, one by one, the radar blips turn an ominous red. The fighter's friend-or-foe identification circuitry has done its job. "Bogies," the machine informs the pilot in a humorless synthetic voice that sounds like it works for the telephone company. "Three of us against seven of them, with orders to engage," the pilot tells himself. "I need a plan of attack... quick.

"Virtual world," he barks into the microphone in his oxygen mask. The inside of his visor fills with a daylit color image of the night skies ahead. The seven approaching targets appear with inverted cones that depict the range of their airborne radars projecting from their noses. "They're still a few minutes away," he thinks, focusing for a moment on the time-to-intercept numbers ticking away at the edge of his vision.

Three of the oncoming targets are flying ahead of the remaining four. The pilot fixes his gaze on the nearest one. "Range?" he queries. A blinking window next to the lead aircraft shows 118 miles. "Altitude?" The display reads 37,000 feet. "Time to AMRAAM range?" he asks. Two minutes, 10 seconds, the display indicates. Then he can fire one of his medium-range air-to-air missiles. "Advisory, AMRAAM, enter," the pilot orders. The aircraft will remind him when missile-launch time has arrived.

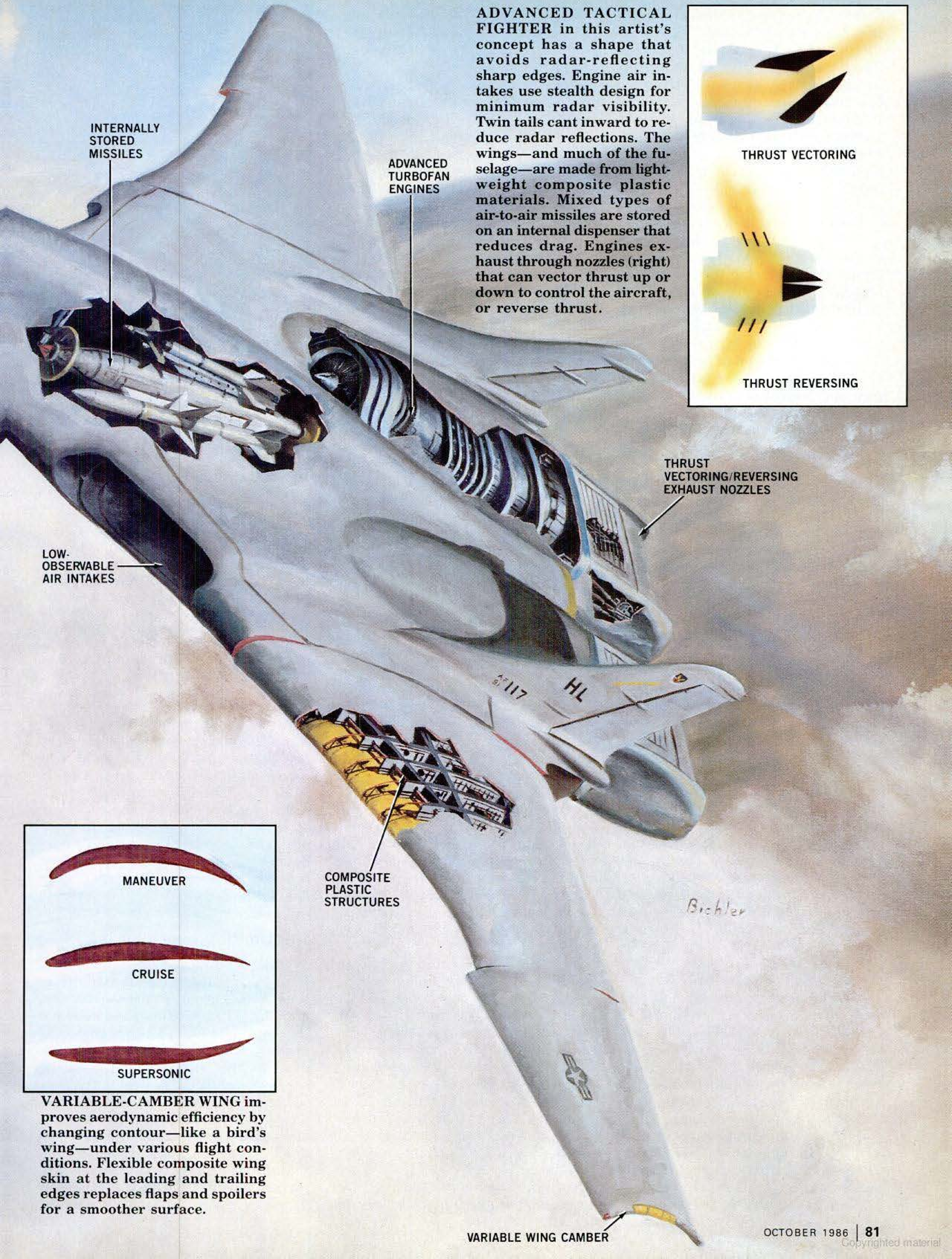
"God's eye," the pilot commands. Immediately, like a celestial being, he is looking down from above on his area of the sky. From the God's eye view he sees his own aircraft in the middle of the scene. To the left are his two wingmen, marked in blue. Ahead are the seven red intruders, the symbolic cones of their search radars moving steadily nearer. The pilot locks his eyes on the image of the lead enemy fighter. "Target, AMRAAM," he orders, marking the enemy for his first missile shot. Transmitting over a radio link, he designates the next pair of targets for standoff shots by his wingmen. Their acknowledgments appear on the display.

Dominate the skies

This is what the scene might look like from the pilot's point of view just before a dogfight, around the year 2000. With such scenarios in mind, the U.S. Air Force is planning fast, agile, highly computerized aircraft that will pit the keen edge of American technology against the vastly greater number of aircraft Soviet forces are expected to field.

Right now, a smorgasbord of fighter

Continued


INTERNALLY STORED MISSILES
ADVANCED TURBOFAN ENGINES
THRUST VECTORING
THRUST REVERSING
THRUST VECTORING/REVERSING EXHAUST NOZZLES
LOW-OBSERVABLE AIR INTAKES
HL
117
COMPOSITE PLASTIC STRUCTURES
MANEUVER
CRUISE
SUPERSONIC
VARIABLE WING CAMBER

ADVANCED TACTICAL FIGHTER in this artist's concept has a shape that avoids radar-reflecting sharp edges. Engine air intakes use stealth design for minimum radar visibility. Twin tails cant inward to reduce radar reflections. The wings—and much of the fuselage—are made from lightweight composite plastic materials. Mixed types of air-to-air missiles are stored on an internal dispenser that reduces drag. Engines exhaust through nozzles (right) that can vector thrust up or down to control the aircraft, or reverse thrust.

VARIABLE-CAMBER WING improves aerodynamic efficiency by changing contour—like a bird's wing—under various flight conditions. Flexible composite wing skin at the leading and trailing edges replaces flaps and spoilers for a smoother surface.

technology research and development programs is underway at U.S. government and industrial laboratories. Seven competing aircraft companies are in the late stages of sorting out the most technically feasible and affordable ideas as they refine their designs for the superfighter of the future. Right now the Air Force is choosing a pair of contractors to build two different fighter prototypes—the YF-22 and YF-23—that will be pitted head-to-head in performance trials.

The final result will be the advanced tactical fighter (ATF), an airplane aimed at dominating the skies starting about 1995. I spoke with Air Force officers and scientists as well as engineers in the aerospace industry to get a picture of the emerging shape of this next-generation fighter. It promises to expand dramatically the range of what men and machines can do in the sky. And it will get tomorrow's pilot to the scene of the action terrifically fast.

Supersonic cruise

"Advisory, AMRAAM," the toneless voice drones in the pilot's headphones. Now the lead targets are in missile range. The pilot reaches for the lone toggle switch on the display panel; everything else is controlled by voice or touch-sensitive overlays. He flips the master-arm switch to "on." "Weapon, select AMRAAM," he orders. "Arm AMRAAM." Then, "Fire AMRAAM." His two wingmen do likewise. Three fiery trails streak off into the night.

Cruising at 50,000 feet, with its twin turbojets running at partial throttle setting, the aircraft's speed is Mach 1.6—about 1,200 mph. The vivid green Mach number glows at the corner of his field of vision. "Let's go," snaps the wing leader. As he jams the throttles forward, the sleek gray fighter's speed increases rapidly to Mach 1.9. Afterburners wait in reserve in case a sprint up to Mach 2.5 is needed. "Status, engines?" he inquires. A symbolic representation of the twin turbines behind him appears. All the sections—inlet, compressor, combustor—are green. "Good," he thinks. "No overheating. The fire's right where it belongs." After five seconds, the image vanishes.

Then for several long moments, all three pilots are completely transfixed by their radar displays. First one, then two, then three red X's appear flashing, motionless. "That was too easy," reflects the wing leader. All the AMRAAMs have found their targets. But now lights and beepers warn that the remaining four enemies have seen the U.S. fighters on their radars. Once again, target designations are handed out.

"The dogfight complexion will change," predicts Col. Albert C. Piccirillo, manager of the Air Force's ATF program. "It won't be a sustained, spiraling fight, as it often has been. It will consist of quick, agile maneuvers, getting weapons on target, and disengaging at supersonic speeds." He makes banking, climbing, and diving motions with his hands to illustrate the aircraft's movements. "Then as soon as you get out of the visual range of the enemy and his wingmen, you are stealthy again."

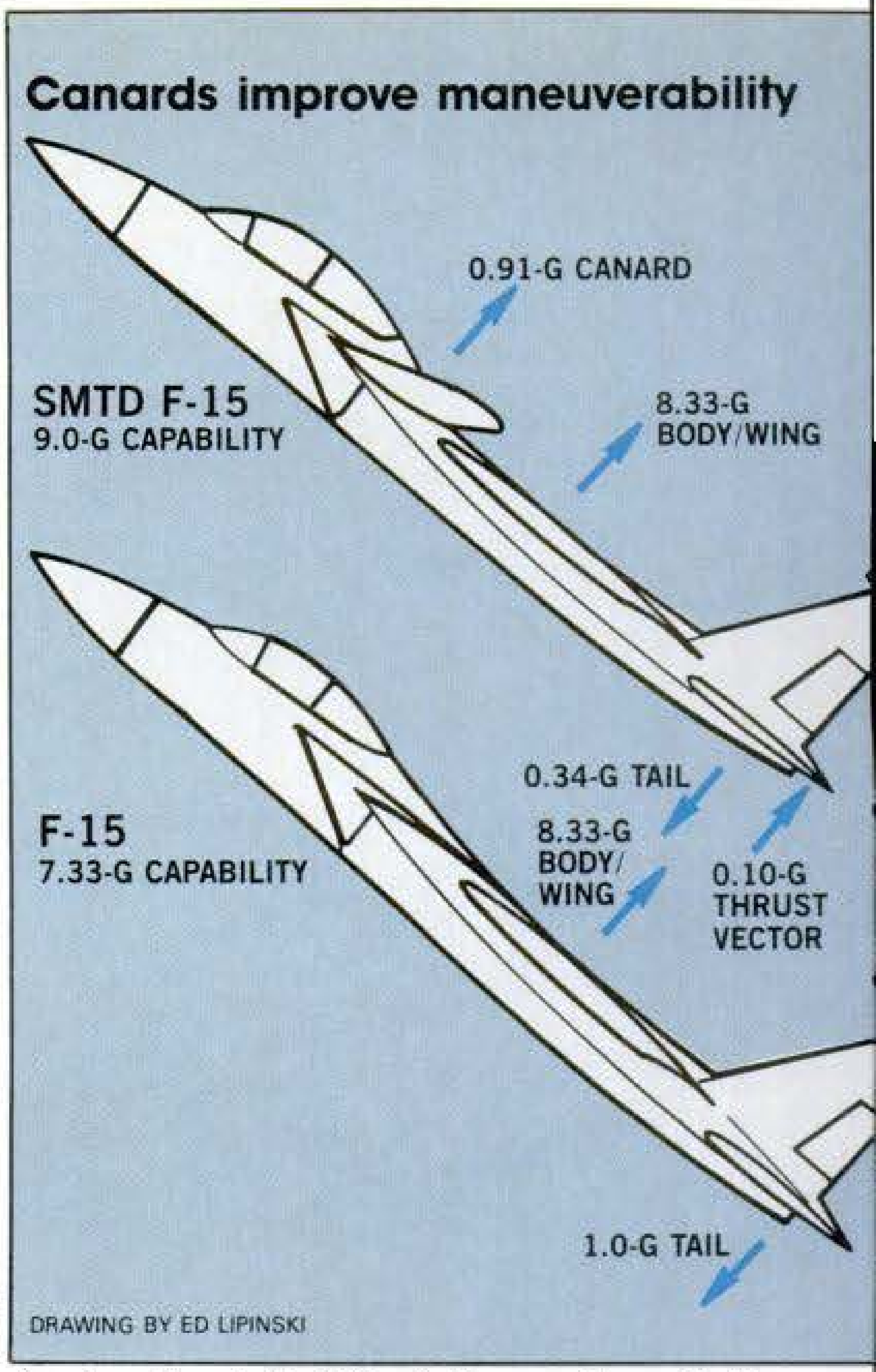
Detailed scale models of airplanes perch on tables and file cabinets in Piccirillo's office at Wright-Patterson Air Force Base, near Dayton, Ohio, a sprawling university-like laboratory complex where the Air Force coordinates a myriad of research and test programs that are aimed at advancing the capabilities of military aircraft. "Pilot skills will become more physical in the sense of G's, and more intellectual in the sense that he'll have far more data and information to work with," Piccirillo reflects. "The pilot's going to be like the captain of a U-boat. But instead of looking out through a periscope, he can call for the God's eye view. Then it's just like looking down at a video game. He has the situational awareness to make the right decisions."

The dogfight takes shape almost before the seven pilots know they're in it. "God's eye," the wing leader orders. "Threat priority." The aircraft's computer responds instantly. An enemy airplane turning tight four miles out at his 3 o'clock position flashes in the three-dimensional display. "Bore site," he orders. Now he's looking straight ahead.

"I've got to get behind this guy," the pilot tells himself, tightening his fighter's rate of turn. As the G forces build up, the airplane's wing camber becomes more pronounced; its leading and trailing edges automatically droop to enhance maneuverability. At the same time, movable exhaust nozzles on the engines vector their awesome thrust slightly upward for a tighter turning radius.

In the driver's seat, upper- and lower-body G-suits instantly inflate with air, tightly squeezing the pilot's body to raise his blood pressure and keep him from passing out. High-pressure oxygen is forced into his constricted lungs, and the ejection seat automatically reclines several degrees as he labors to stay alert under nine times the force of gravity. The tight turn is worth it. The wider-turning enemy is in his sights. He dispatches him with a heat-seeking missile.

Switching back to the God's eye view, his stomach tightens when he sees another enemy closing in from behind with one of his wingmen in pursuit. The airplane shudders slightly, then he briefly engages reverse thrust. His fighter buffets under the stress, and he feels as if his eyes will pop out of his head. But it works. Having scrubbed off a few hundred miles per hour of air speed, he watches enemy and wingman streak past overhead. A moment later, the wingman also scores a missile hit. Radar shows that the remaining two enemies have gone home.



DRAWING BY ED LIPINSKI

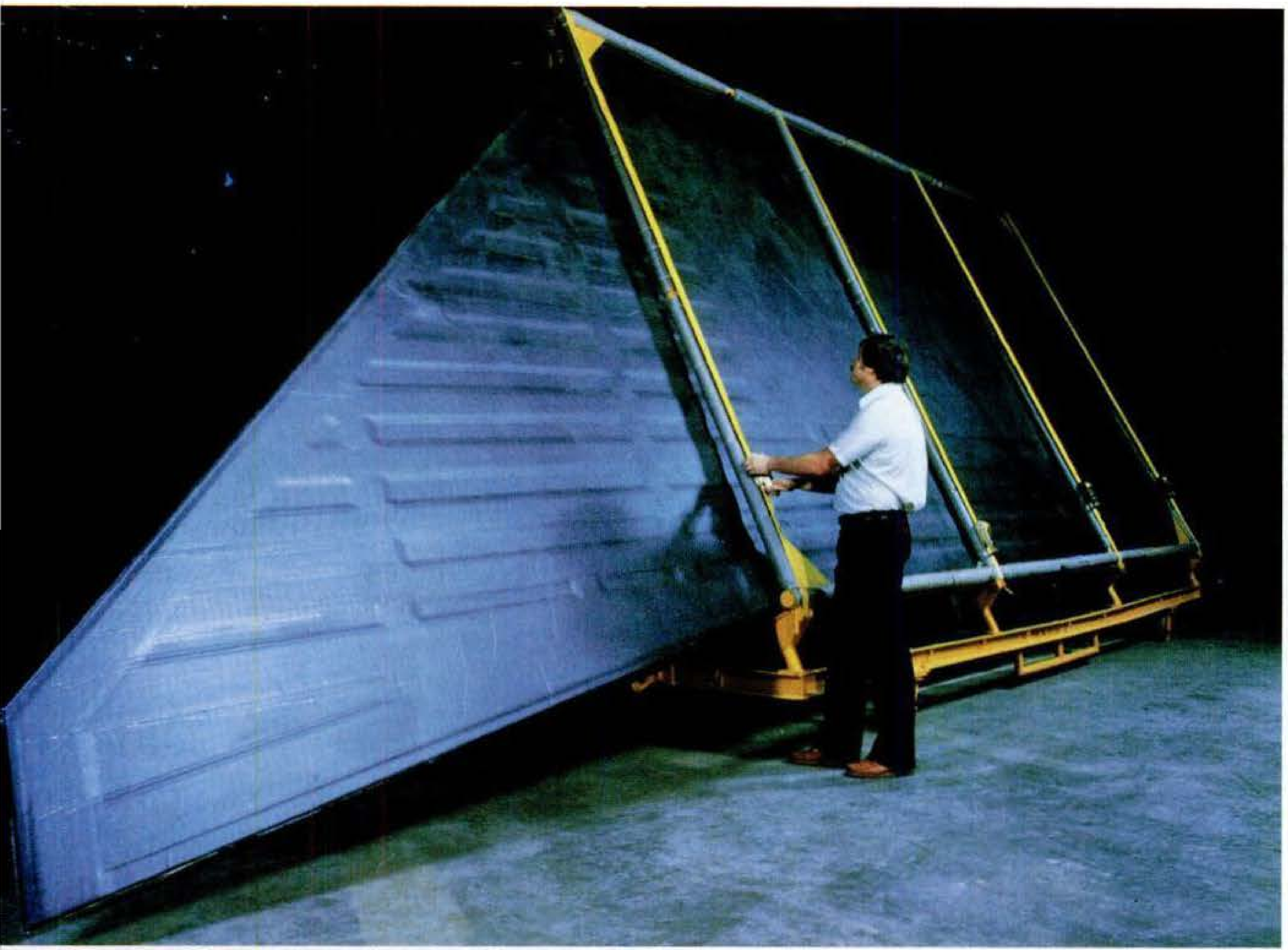
A standard F-15's tail exerts a 1-G down-force to balance the 8.33-G upforce of its body and wings, making the aircraft stable. With added canards and thrust-vectoring exhaust nozzles, the STOL and maneuvering technology demonstrator F-15 has increased G-load capability for tighter turning. A digital flight-control system adjusts canard angle to keep the airplane stable, reducing the down-force—and consequently drag—at the tail.

Information overload

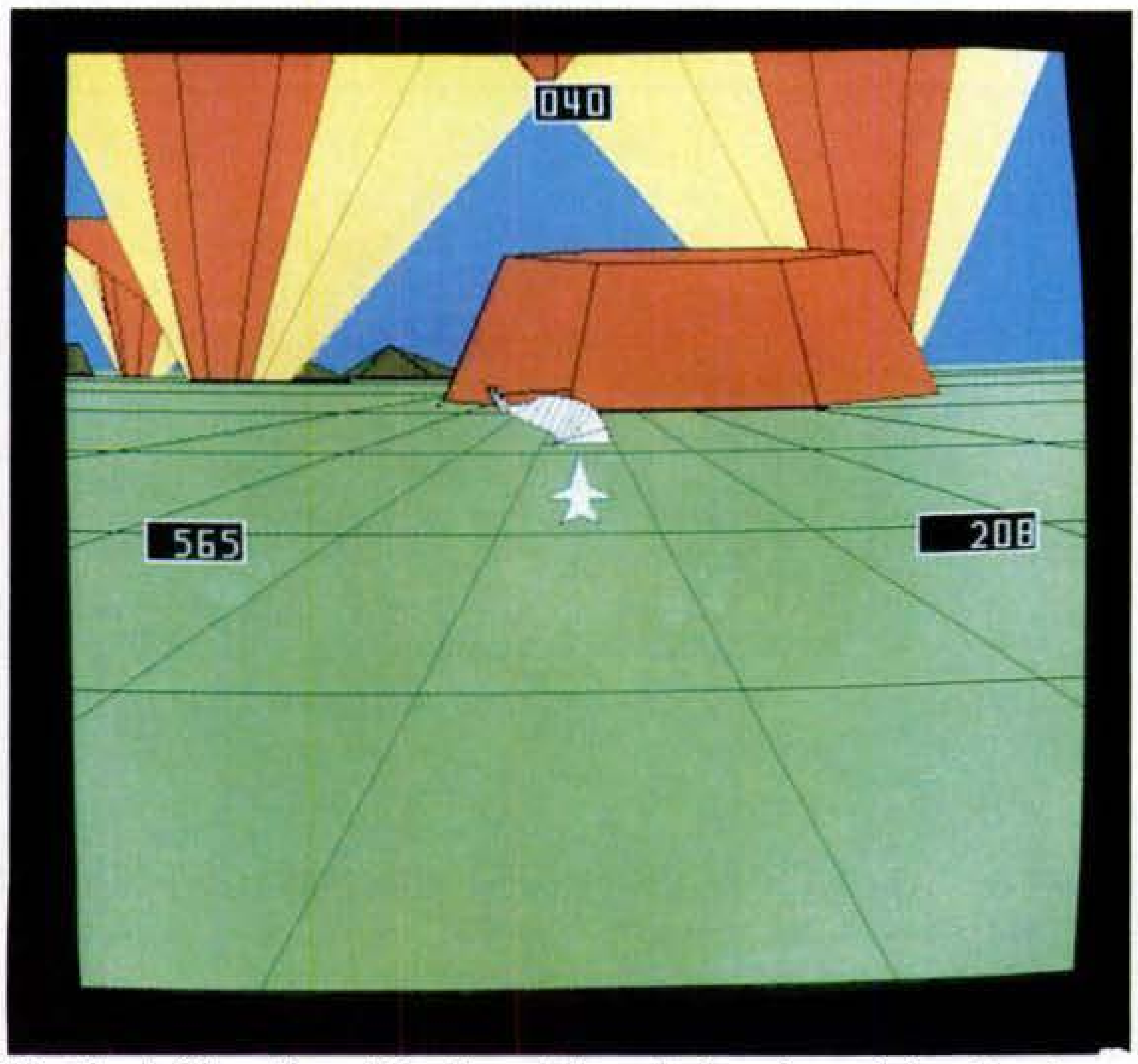
"Tons of information will flow in from the radars, infrared, and other sensors. We have to prioritize it so the pilot doesn't have to land and head for the psychiatrist," says Sherman N. Mullin, vice president and ATF general manager at Lockheed-California Co. in Burbank, Calif. Visible through the office windows as we talk are the Skunk Works buildings where legendary aircraft such as the the U-2 and SR-71 spy planes were developed.

Mullin thinks that tying all the airplane's electronic systems together

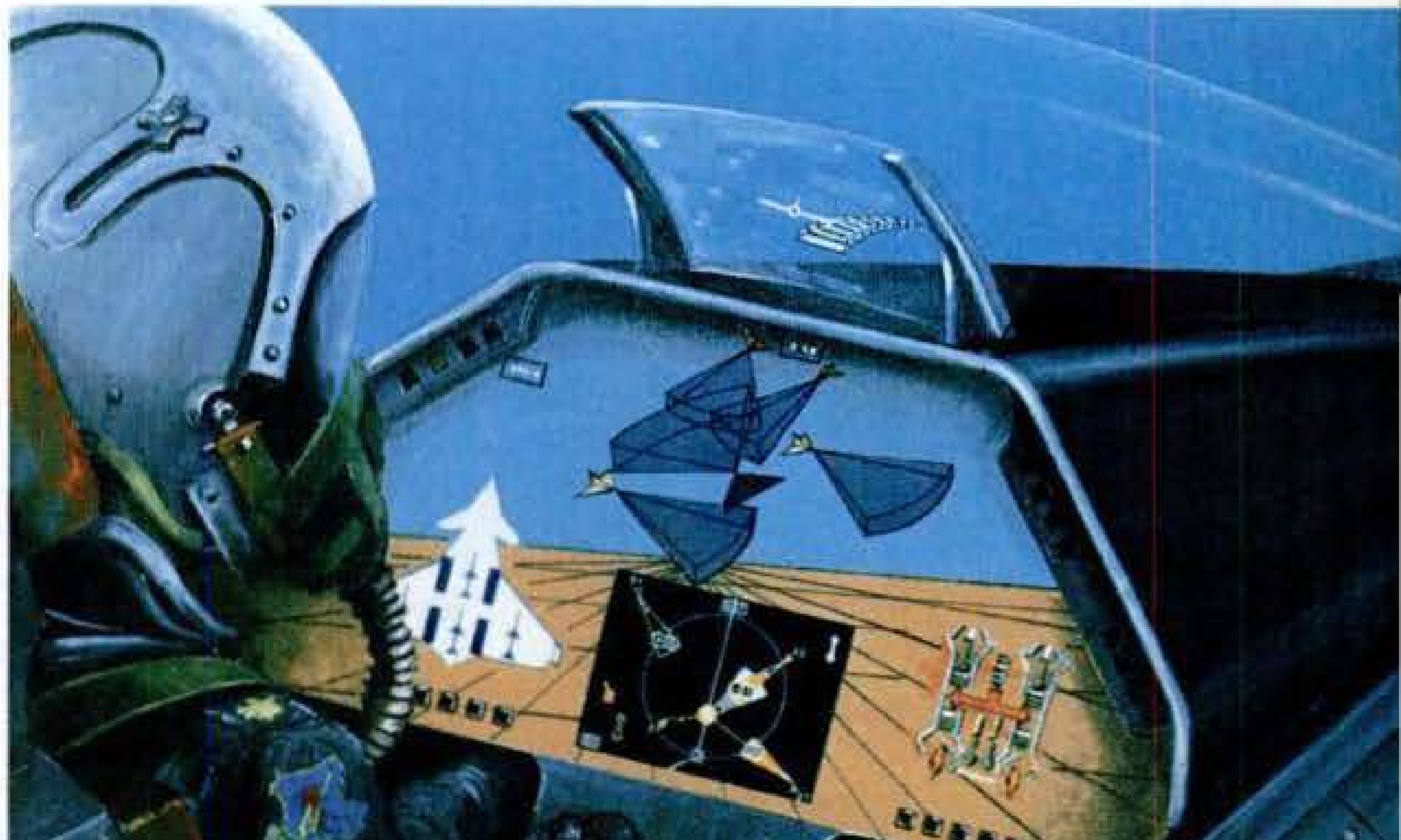
Continued

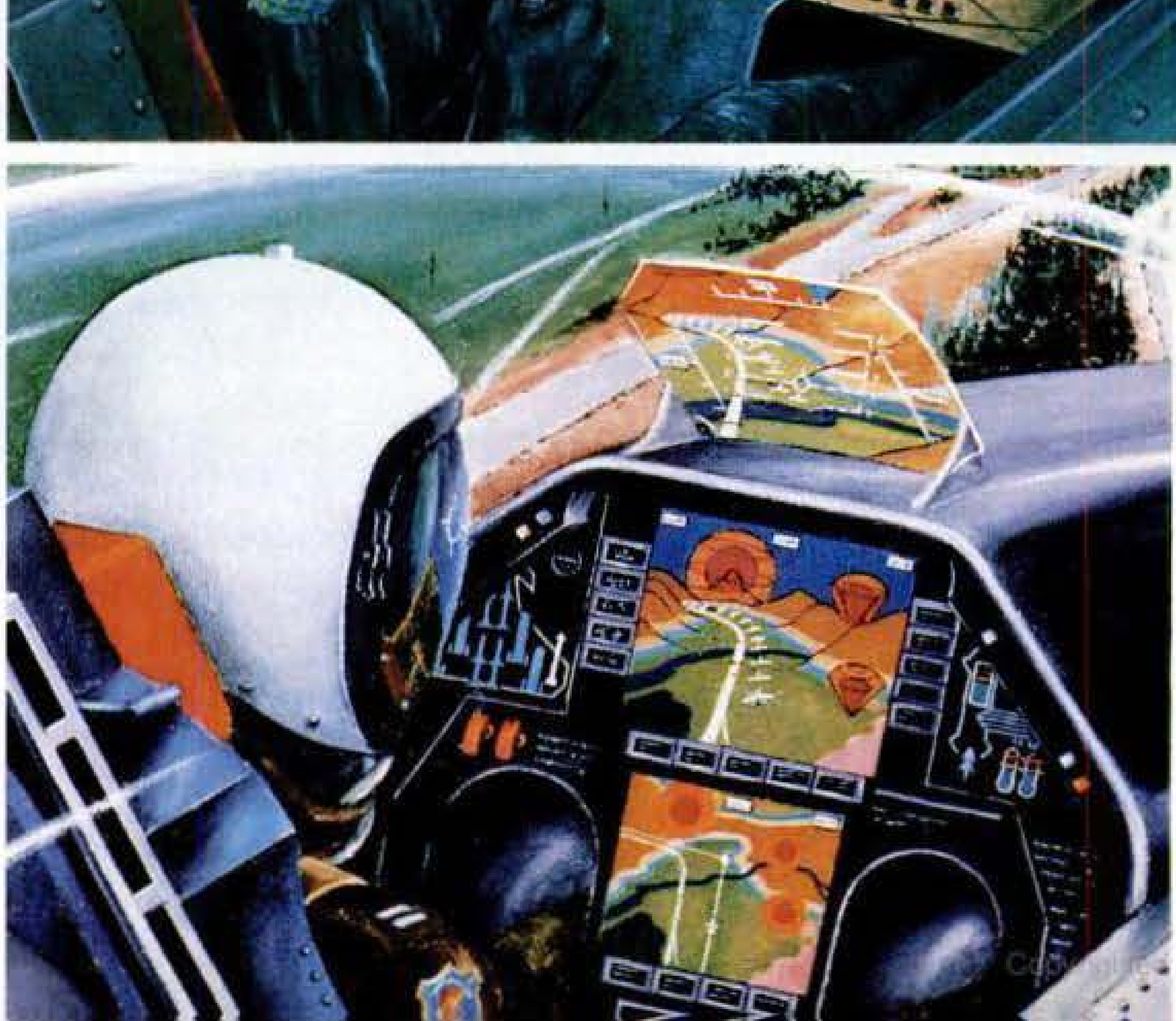


Upper and lower composite wing skins (above) were built by Boeing from lightweight graphite-fiber fabric embedded in thermoplastic. The material is tough and easy to repair; subassemblies can be welded together by heat and pressure.



Vertical Situation Display (above) developed by Boeing shows major topographical features ahead of an aircraft. Red and yellow beams show the severity of threats from ground-based missiles and guns. The "ribbon" road in the sky shows the pilot path to follow to minimize risk. The scene is viewed from the God's eye perspective; the pilot sees his own airplane from above and behind. Cockpit displays at right show enemy-fighter radar, weapons stores, engine status, navigational data, and best flight path.





effectively is one of the greatest challenges in the ATF program. "Sensor fusion—sorting out all this information to give the pilot the best situation awareness—requires lots of simulation and writing of software."

Central to the computerization of aircraft is the development of very high-speed integrated circuitry (VHSIC), a research effort that's high on the Pentagon's priority list.

"ATF is a plastic airplane filled with software," Mullin declares. "The airplane will have an unprecedented amount of software and plastic composites in it."

"I've got a 5-G turn limit and a Mach 1.5 airspeed limit on the display," the wing leader reports as the three fighters pull into formation for the flight back to base. Dropping back to take a look, a wingman sees the cause. "Your right vertical tail looks like it's taken a half-dozen cannon rounds." Without supervision from the pilot, the digital flight-control system has reconfigured to let the other control surfaces assume the weakened tail's function.

Touching down on the rain-soaked runway at the base with his engines thundering at full-reverse thrust, the pilot still manages to bring his battle-damaged fighter to a stop in 2,000 feet. "Never fails to impress," he muses. "This used to take 7,000 feet in my old F-15."

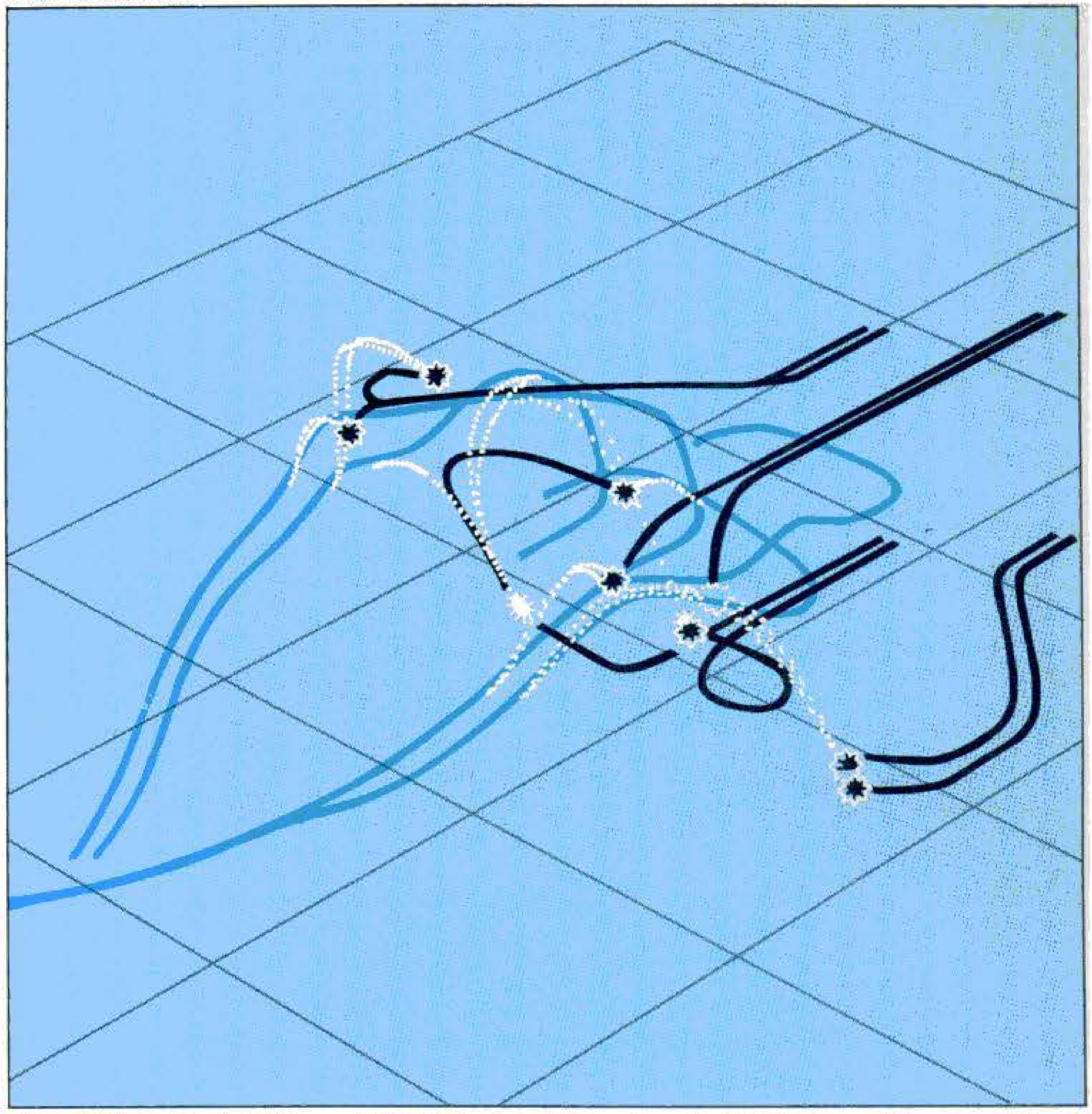
The smart airplane

"I spent a lot of hours flying F-4 Phantoms. In the F-4, you could pull the wings off or break the engine mounts pulling out of a dive," recalls Col. Piccirillo. "The ATF will not let you break it in half; it won't give you any more G's than the structure can take. It will be smart. The pilot doesn't know it, but the digital flight-control system is helping him fly the airplane. He's putting in the gross movements, indicating what he wants to do. The airplane does the fine tuning."

Digital fly-by-wire, a system using high-speed on-board computers to direct movement of the airplane's control surfaces as many as 40 times per second, is one of several key technologies that will help future fighters perform their missions. Advances in jet propulsion, aerodynamics, and radar-evading stealth technology [PS, Sept.] will also contribute to machines suited for a new style of aerial combat.

"We will go in very high—as high as fifty to sixty thousand feet—and very fast with a low radar-signature airplane. We will have electronic countermeasures on board to confuse enemy radars," says Piccirillo. "The idea is to be able to get into his territory covertly using passive sensors such as infrared detectors as much as possible, instead of blasting out radar, which can be picked up."

DRAWING BY ED LIPINSKI



Simulation depicts four ATFs (blue) engaged in a 4.5-min. combat encounter with eight enemy fighters (black). White dash lines are missile tracks. Black stars are missile hits; white star is a miss. Grid lines on the ground are 25 miles apart. Scenarios like this are used to define missions and evaluate the performance of aircraft with different feature combinations.

The need for speed

By cruising supersonically at partial throttle without resorting to its fuel-guzzling afterburners, the ATF will be able to dash to a farther-distant fight than today's fighters can. New propulsion systems play a major role in sustaining efficient cruise speeds as high as Mach 2.

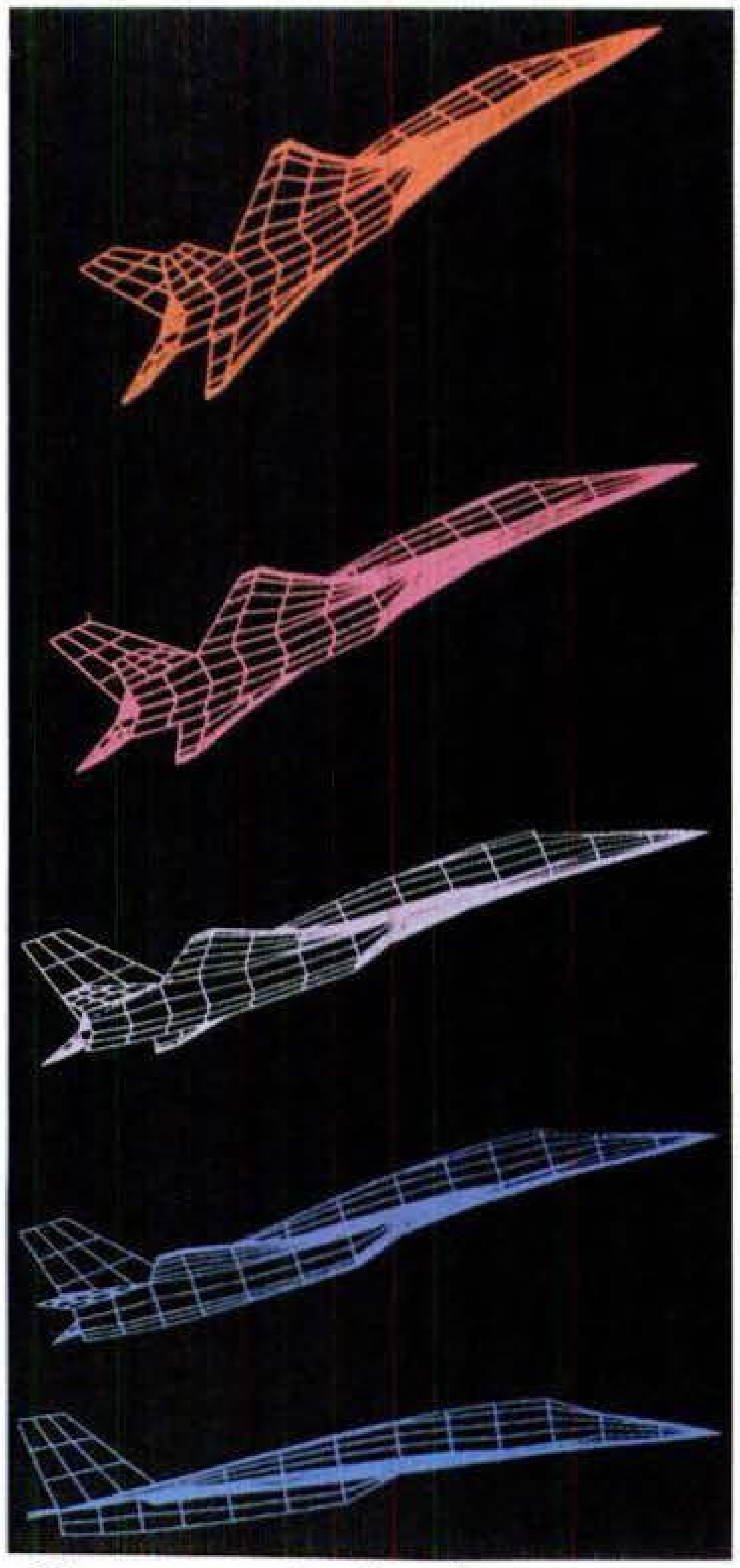
Advanced low-bypass turbofan engines under development by Pratt & Whitney and General Electric Co. will yield dramatic gains in thrust and efficiency at supersonic speeds while having fewer parts. "Supersonically, their thrust-to-weight ratio is about twice that of current fighter engines—at the same fuel-burn rate," Piccirillo says. "Subsonically, they've got twenty to thirty percent more thrust."

A powerful analytical tool, three-dimensional aerodynamic computer modeling, was used to develop the shape of the engines' compressor-turbine blades. "Instead of being long and slender, they are short, squat, and really twisted—almost like ship's propellers," Piccirillo explains. "These shapes give more compression in fewer stages, and are more resistant to damage from ingested debris." Contrarotating turbine wheels will also improve engine efficiency.

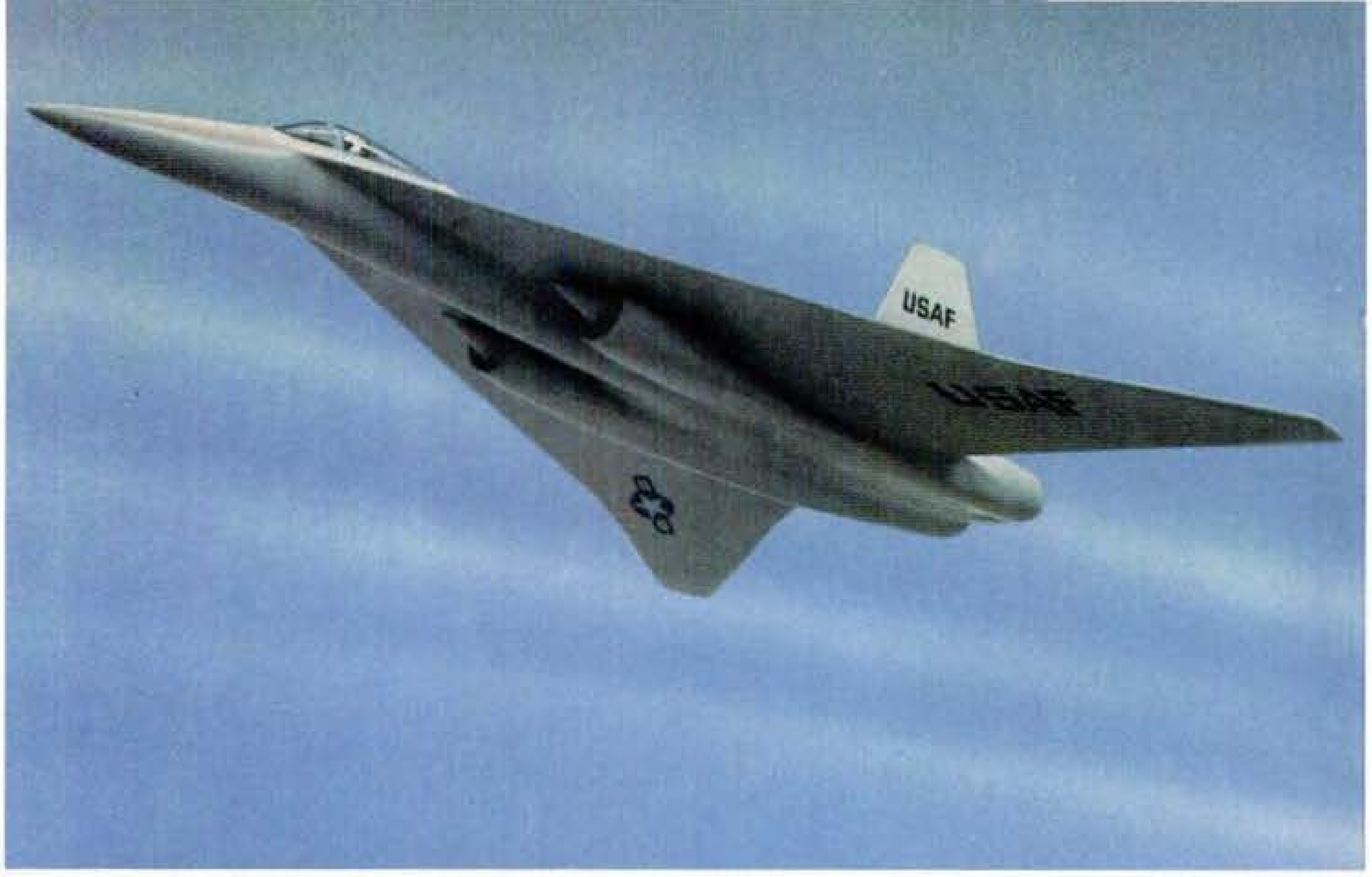
Further gains are provided by an aerodynamically unstable airframe design that permits the use of smaller, lower-drag tail surfaces. Digital flight control constantly corrects the airplane's tendency to tumble out of control. (Conventional aircraft pay a drag penalty for stability by using aerodynamic down-force on the horizontal tail to balance the lift provided by the wings. This fuel-wasting drag at the tail performs the same function as the feathers on an arrow, making the aircraft tend to fly straight and level.)

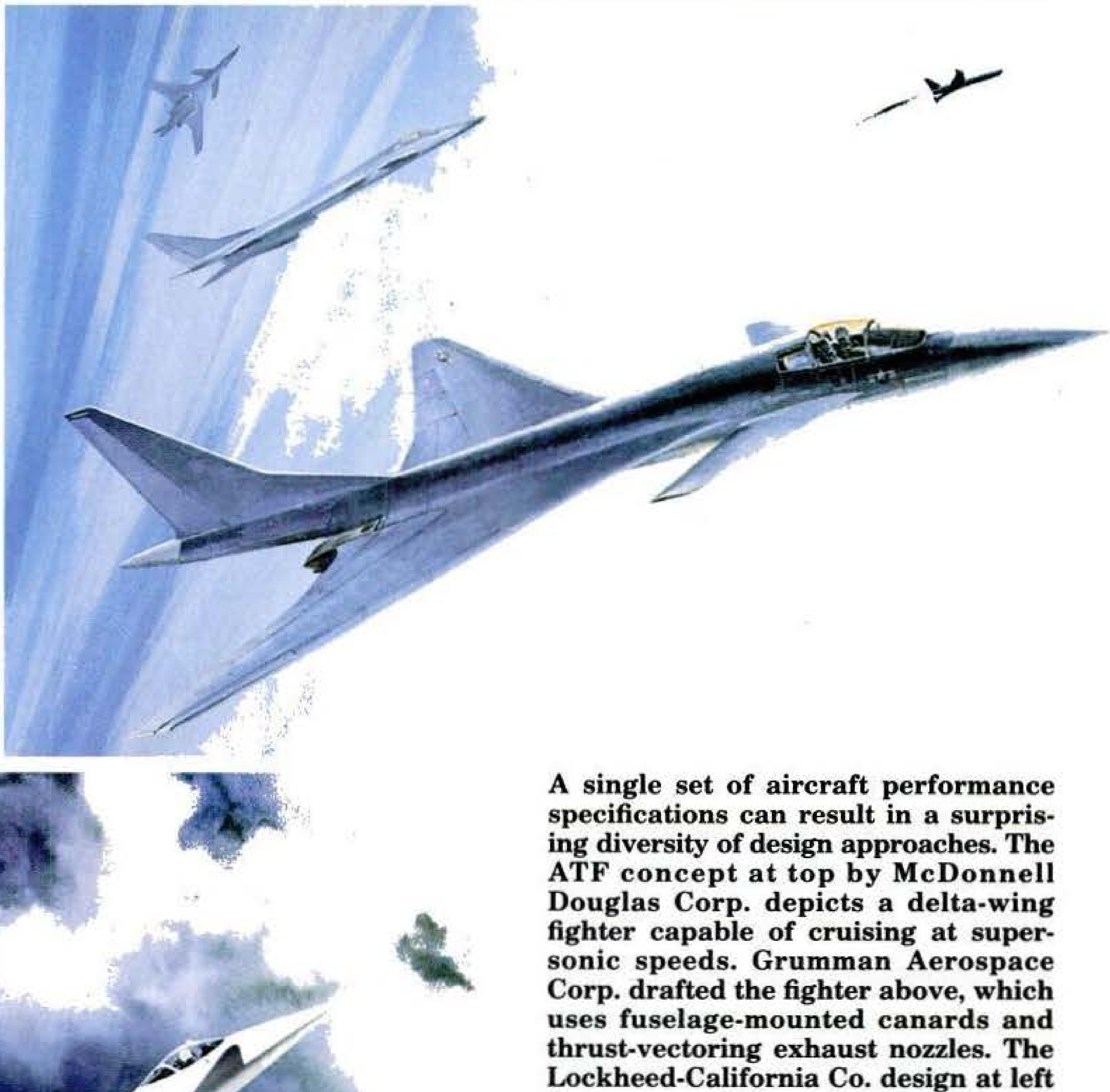
Two other developments make supersonic cruise possible. First, as much as 50 percent of the ATF's structure will be built from advanced composite materials. Along with new light-

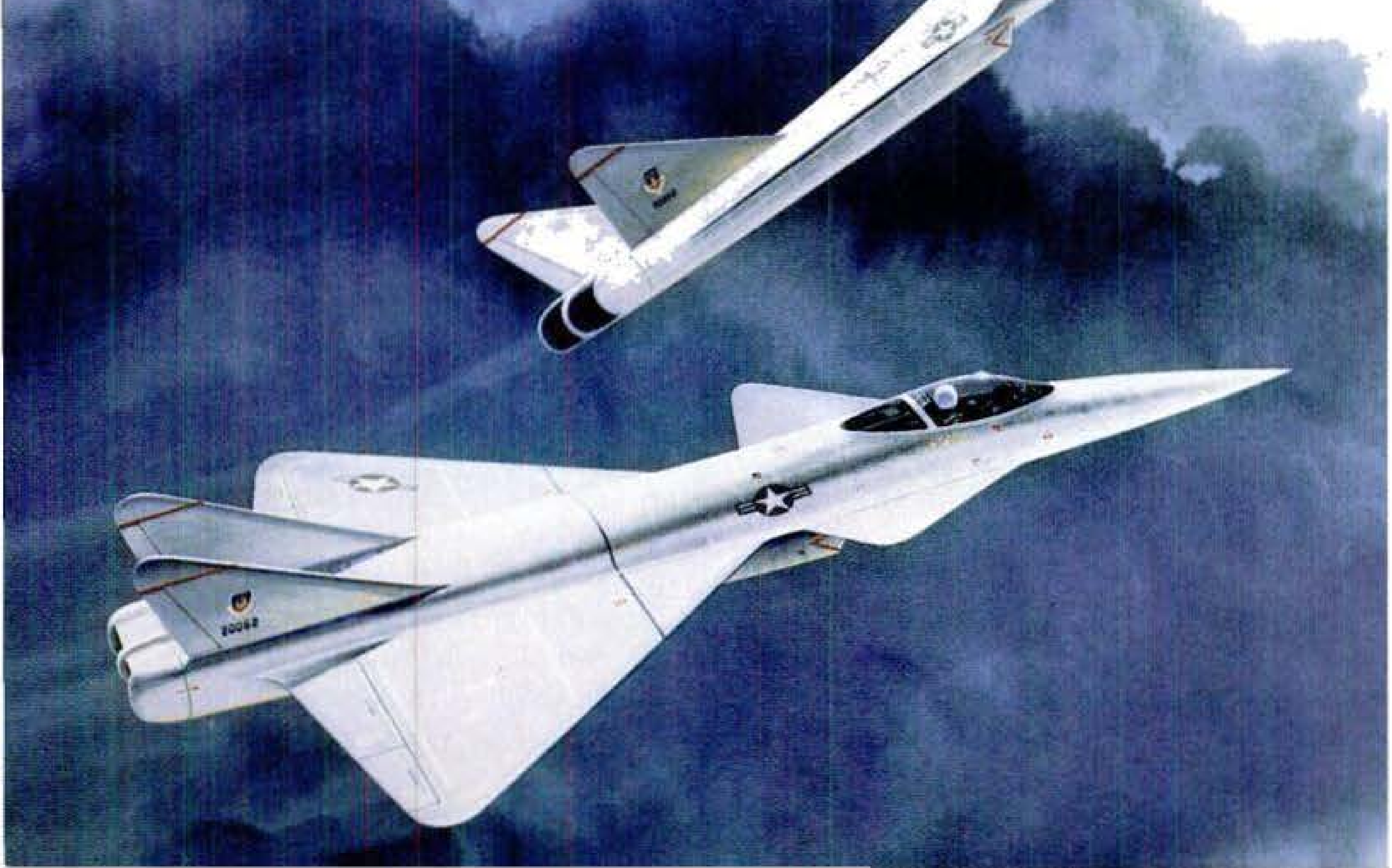
Continued



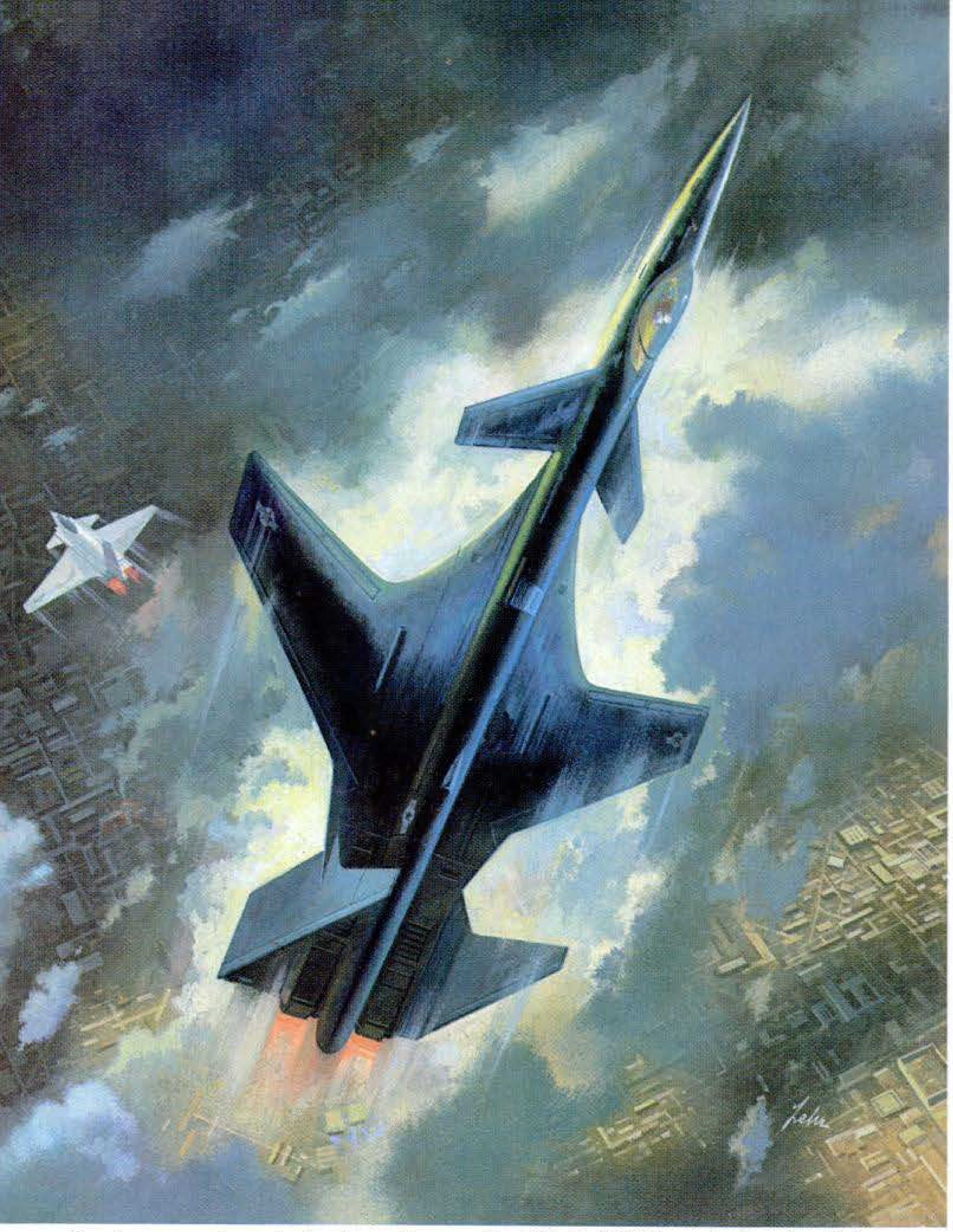
These computer drawings were produced by the PAN AIR aerodynamic computation system. The method is used by Boeing to refine aircraft designs before wind-tunnel tests.







A single set of aircraft performance specifications can result in a surprising diversity of design approaches. The ATF concept at top by McDonnell Douglas Corp. depicts a delta-wing fighter capable of cruising at supersonic speeds. Grumman Aerospace Corp. drafted the fighter above, which uses fuselage-mounted canards and thrust-vectoring exhaust nozzles. The Lockheed-California Co. design at left features carefully sculpted surfaces to minimize radar reflections. Other companies competing to build the ATF are General Dynamics, Northrop Corp., and Rockwell International.



Features under study for advanced fighters include forward-swept wings.

Digital flight control makes this maneuverable but unstable design flyable.

weight aluminum-lithium alloys and ceramic whisker-reinforced metals, they will make the aircraft 20,000 pounds lighter than fighters built entirely from conventional metal alloys.

Second, variable-camber wings will automatically change their curvature in flight to maximize lift and minimize drag for fuel-efficient cruising. Flexing the wings eliminates the need for conventional flaps and ailerons.

Stealth vs. agility

Improvements in Soviet fighters and air-defense radar systems have made it much more difficult to survive the modern-day aerial battle. The advanced technology bomber currently being developed by Northrop Corp. (better known as the stealth bomber), and Lockheed's so-called "F-19" stealth fighter, place primary emphasis on making the aircraft virtually invisible to radar and other sensors. This is done partly by using special materials and coatings that absorb radar signals instead of reflecting them, and partly by equipping the aircraft with sophisticated electronic black boxes that obscure its radar signature.

The primary stealth technique involves paying careful attention to the airplane's shape. Here, it's important to avoid creating sharp edges and large, flat surfaces. Openings such as engine intakes and exhaust nozzles must also be carefully sculpted to minimize their radar reflectivity. The flying characteristics of the pure stealth aircraft, however, will be somewhat compromised by their chief goal of remaining unseen.

With the ATF, the Air Force is demanding a lot: It wants the new fighter to be stealthy *and* a great aerobatic performer at the same time. "Our goal is to have as little impact as possible on performance, size, and cost, and still make the airplane nearly invisible. Minimum profile from any angle is what you're looking for," observes Piccirillo. "We also want the ATF to fly twice as many hours as the F-15 between groundings for unscheduled maintenance," he adds.

Developing passive sensing devices for fighters is another top priority. Because they merely gather signals from external sources instead of emitting any of their own, passive sensors operate without giving away the game to enemy pilots. The development of miniature high-resolution infrared imaging devices should give pilots the ability to see well-defined TV images of aircraft more than 10 miles distant —at night.

Called focal-plane arrays, these sensors see the heat energy radiated by an aircraft's engines and structures and use it to generate an image. One version, developed by the Electro-Mechanical Division of Northrop Corp., has 16,384 sensors packed onto a ⅓-inch-square semiconductor chip. The sensor array's compactness makes it suitable for air-superiority fighters where size and weight are critical considerations.

Radar is also changing. Flat-plate phased-array antenna designs use as many as 1,600 small microwave emitter-receiver units that scan the sky electronically, gathering data more rapidly than conventional parabolic-dish antennas, which must rotate quickly within the aircraft's nose. A phased array can have malfunctions in as many as 15 percent of its small emitter-receiver modules without suffering a major decrease in its performance.

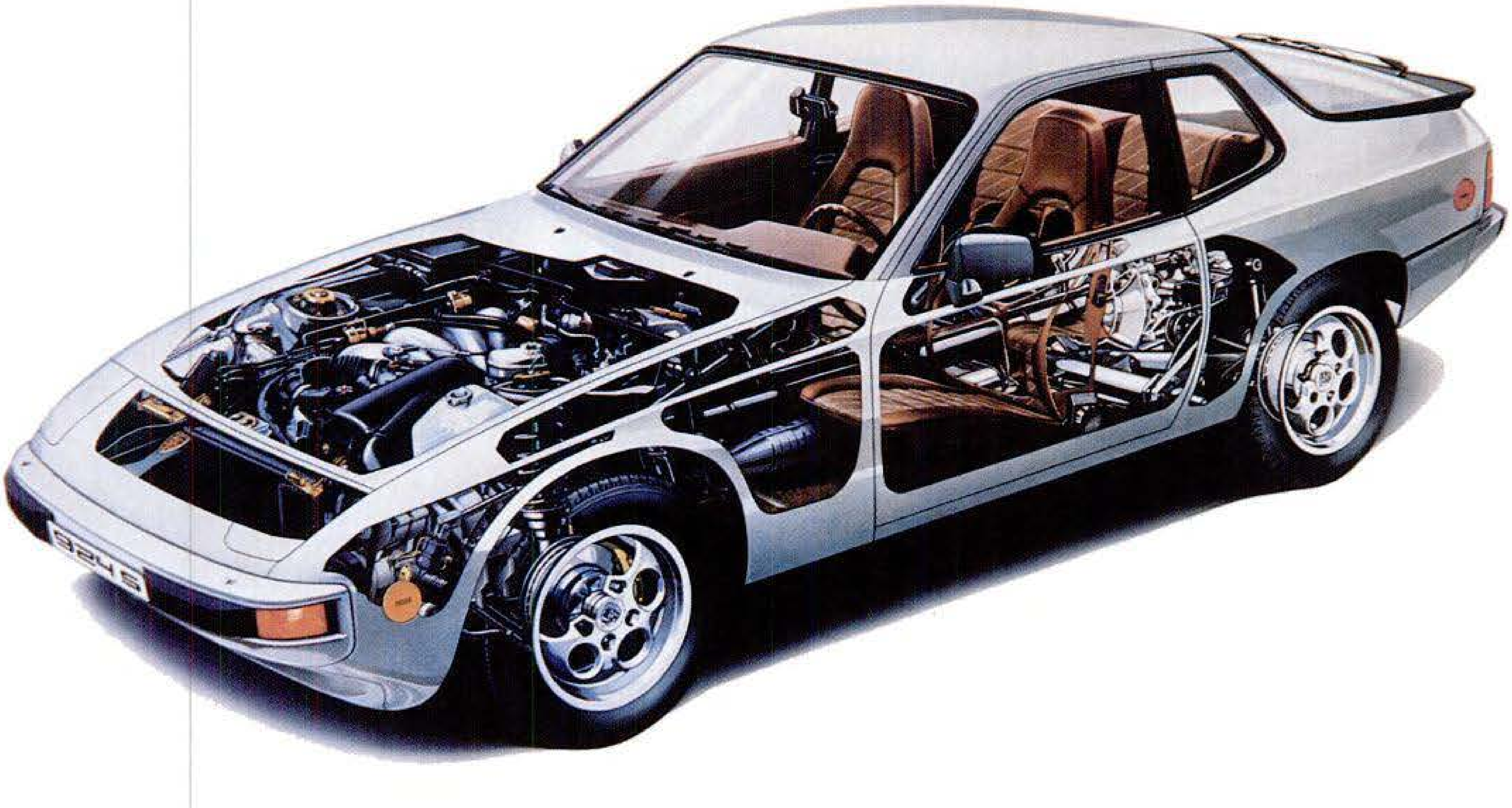
Phased-array antennas also offer the advantage of being less visible to enemy radar than are the parabolic dish types. Further, it may be possible to save weight and space by performing multiple functions—such as radar, electronic countermeasures, missile warning, and friend-or-foe identification—through time-sharing on a single broad-band phased-array antenna.

The design trade-offs

Aircraft designers are scrambling to meet the Air Force's demand for a fighter that's both agile and stealthy. Sitting in a fenced-off warehouse in the shadow of a prototype graphite-thermoplastic composite fighter wing (see photo), Richard Hardy, ATF program manager at Boeing Military Airplane Co. in Seattle, describes to me how his company uses computers to handle the design tug-of-war.

"Stealth versus agility is the key design trade for ATF. It's not a simple problem. We simulated hundreds of

[*Continued on page 112*]



Cutaway of the 924S reveals the same 2.5-liter engine, rear-mounted transaxle, and independent suspension as the 944.

Poor man's Porsche

Never thought you'd see a $20,000 Porsche again? Here's the 924S, created by wedding the 924 body to the current 944 chassis. It may be one of the best Porsches yet.

By DAN McCOSH
Detroit Editor

Driving Porsche's new 924S through the hills of northern Georgia is a trip through a time warp. The Old South's shotgun shacks stick to the bottom land. The rural retreats of the New South's high-tech barons perch atop the hills. The road is a twisted snake, everything but straight. It's the kind of road that trains NASCAR drivers and moonshiners. It's enough to make you want to run whiskey in a bright red Porsche.

Like the Old South, the 924S has a colorful past. Five years ago, for reasons of its own, Porsche withdrew the popular 924 from the U.S. market. Now, after a monkey-gland treatment in Europe, the 924 is back. Its body shell has been wedded to a 944 chassis, complete with the 2.5-liter Porsche engine and all major suspension components. It's this new version of the 924—renamed the 924S—that is being introduced in the U.S. this fall. An introductory price of $19,995 makes it today's cheapest Porsche, $4,500 less than the basic 944.

Grafting the 10-year-old 924 body onto the 944 chassis and calling the result a new car may seem a bit odd. But the 924S is a successful reincarnation of the best of the old Porsche spirit—a premium sports car with no engineering compromises, and one that truly works.

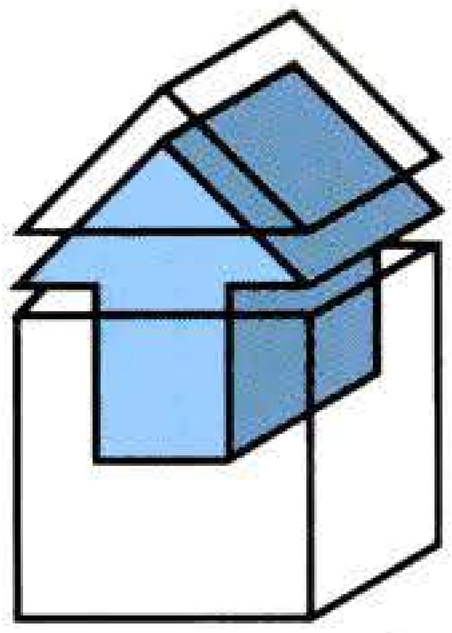
"There's really only one technical difference between the 924S and the 944," said Hans Struffert, Porsche general manager of corporate service. "That's the steering control arm. In the 924S, it's stamped; in the 944, it's forged."

The power plant for the 924S is the same 2.5-liter, all-aluminum four-cylinder used in the 944. It produces 147 horsepower at 5,800 rpm and 140 foot-pounds of torque at 3,000 rpm. Like all Porsche engines, it features cast aluminum cylinders with etched-silicon bores. The engine also uses twin countershafts for balancing.

The front-engine, rear-transaxle layout is the opposite of the thinking that yields a mid-engine sports car. Putting distance between the two heaviest components in the car increases the polar moment of inertia—the tendency of the car to resist deviating from a given course. On the 924S, this dampens out two of the aggravations associated with rear-drive sports cars. The rear axles don't thump, because the mass of the rear transmission gives the suspension something to work against, and power oversteer is reduced, because the rear axle has more bite under power. The penalty for this high polar moment is slower response to steering inputs. But most drivers find this simply gives them more time to catch mistakes.

The 924S is about 20 pounds lighter than the 944. Porsche says that at 131 mph it is also 3 mph faster. Subjectively, there is a big difference between the two. The 924S is a smaller package that feels more supple. The 944 is bulkier, more aggressive, with a stiffer-feeling body.

Clearly, the 924S is a prelude to upgrading the 944. Meanwhile, the upstart 924S is both cheaper and faster than the 944, something likely to cause grumbling among old-guard Porsche owners. PS



ROOM AT THE TOP

Raise your roof

to get more space for less money

Space in your house tight? Money tight? Attic height tight? If you've answered yes to at least two of these questions, you might want to consider raising the roof of your house. This project shows how you can make this affordable addition to gain more space in your place—without moving or expanding the boundaries of your home.

By TIMOTHY O. BAKKE
Structural carpentry: Hans Bakke

Standing at the bottom of my attic stairs in the living room, I look up. All I see is blue sky—I've just finished ripping the roof off my small house. I hope clear sky is all I'll see for at least five days. Please, no rain till I get my roof back on. Now I know how Noah must have felt as he labored on his Ark, anticipating the Deluge.

A few years ago, my wife, Marion, and I bought a two-bedroom ranch with an eye to doing something with it in the future. The future came fast. Our son was born soon afterward, and we found ourselves in the same boat many Americans are in: We were cramped for space but didn't want to move. (A recent National Assn. of Home Builders report states that the number-one remodeling job in 1986 has been room additions, indicating that the add-on-rather-than-move-out trend is in full force.)

To ease the crunch, we decided to build an upper floor, almost doubling our living space. Our design is applicable to any ranch-style house (see drawing, page 90). Going up instead of out to gain more room can be a sensible way to go for many homeowners. It can be cheaper than excavating to extend a foundation. Zoning restrictions or small lot size might even preclude outward expansion. Hooking up with utilities is easier when you stack-build. Splicing into your heating system is more convenient; in fact you usually don't have to upgrade your heating plant when you extend upward and have an open floor plan. And you can radically change the look of your house in the bargain. Our decision was based on solving a number of problems with one stroke:

- Space was tight, but so was money. I wanted to do most of the work to save labor costs, and I didn't want to tackle foundation work.
- In an apparent siting error, the living room faces north. Because it got no direct light, it always seemed dark and dreary. Removing the living-room ceiling and putting skylights on the south side of the roof would provide natural lighting for our living area.
- We wanted a second bath, but doing anything but hooking up to existing plumbing runs would have been prohibitive.
- We wanted more entertainment space, and hanging a second-level cantilevered deck off a family den would provide it—with interest.
- Existing head room in the attic was useless, so putting on a new, higher, roof would make the *entire* second-story floor space usable. (Most attic renovations make use of only a portion of the floor space.)
- The original roof needed structural repair anyway.

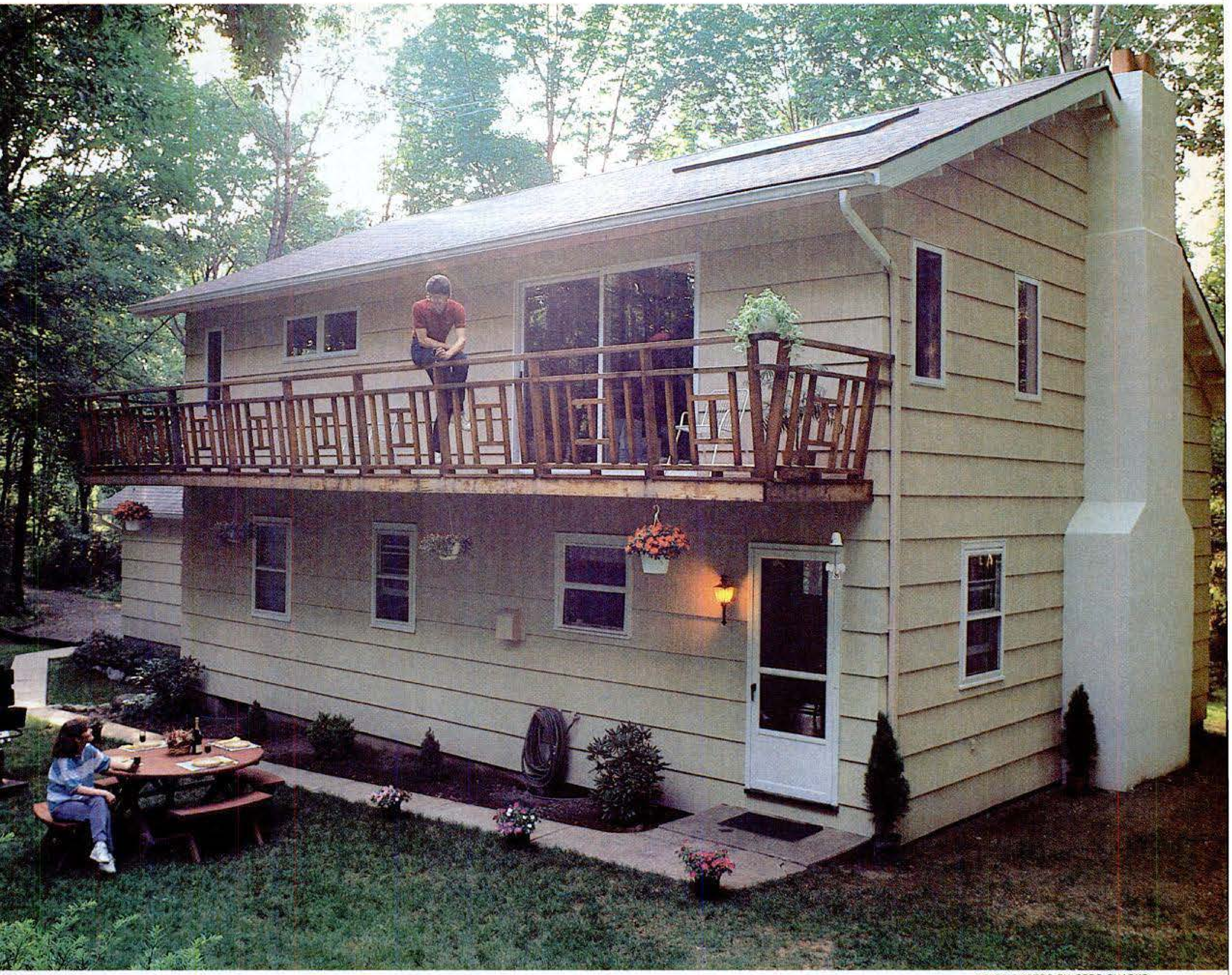
The result is a well-lighted living room with a 20-foot vaulted ceiling and an upstairs consisting of a 12-by-18-foot den area and 14-by-16-foot master bedroom (with 12-foot cathedral ceilings), a 7-by-11-foot bath, an office nook, generous storage space, and a cantilevered redwood deck running the length of the house. This article—the first of three on my project—covers structural construction. The interior and master bath will be detailed in future issues.

With the old roof gone, we are about to begin framing for the new asymmetrical roof, which will have a ridgepole about 5½ feet higher than the previous 6½-foot-high ridge. This is turning out to be a big—and traumatic—job. A thick layer of debris surrounds the house as if a violent whirlwind had ripped by; my vulnerable house with all my belongings yawns wide open; and butterflies flutter in my stomach as we set to our task.

One of the best reasons for going up is saving costs. You'll need to have plans made; you'll need a good framing carpenter to put up the basic structure; and you'll probably need a plumber and an electrician. But if you're handy and don't mind hard labor, you can do all the other work yourself. I was lucky enough to have my father, a retired carpenter contractor with more than 40 years of experience, help me frame the structure. His kind of expertise is *essential* in a project like this. But I was able to sheathe and shingle the roof, side the house, and do most of the interior work myself, saving a bundle. Remember, however, that a job like this is tremendous, and the trade-off is time: Going this route takes endurance and months of hard work if you devote your weekends and vacation time to it. (General rule of thumb: Estimate how long something will take, then triple it. This way you'll remain only slightly behind schedule.)

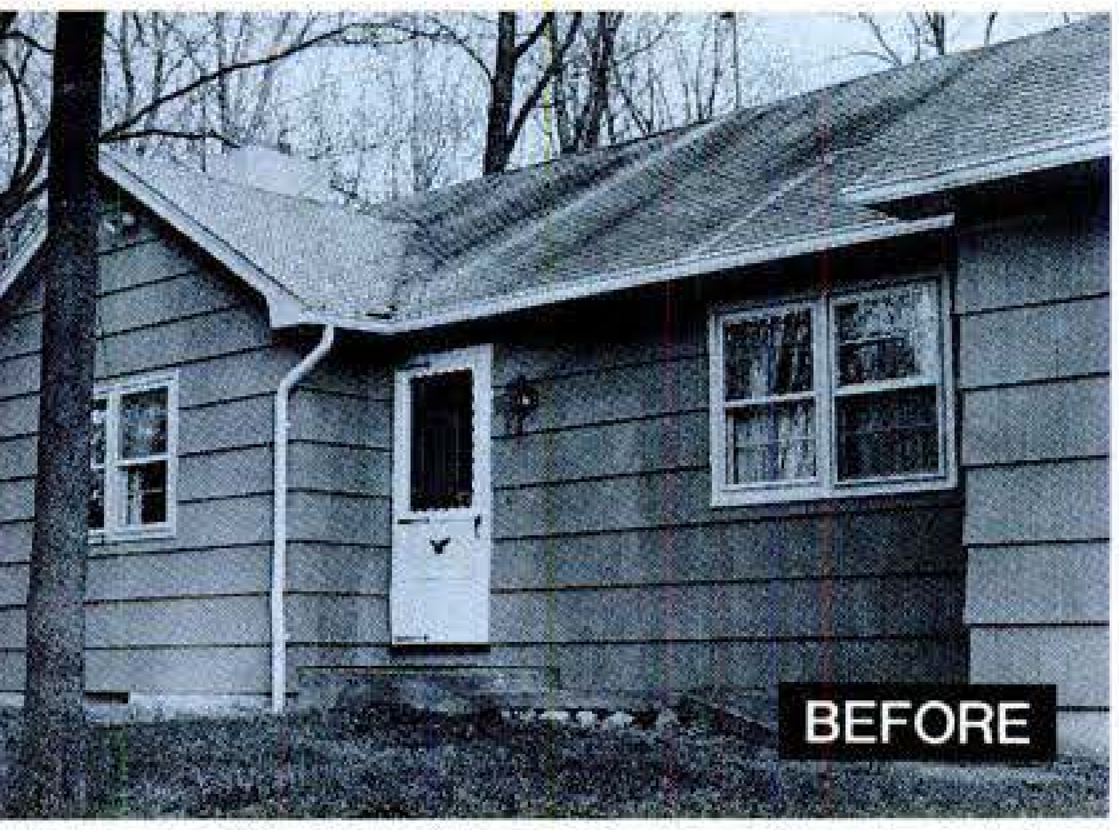
Before you talk to an architect, know precisely what you want to accomplish, and have some ideas on how you want to do it. To a certain extent, our requirements dictated the project's design. For example, the south side

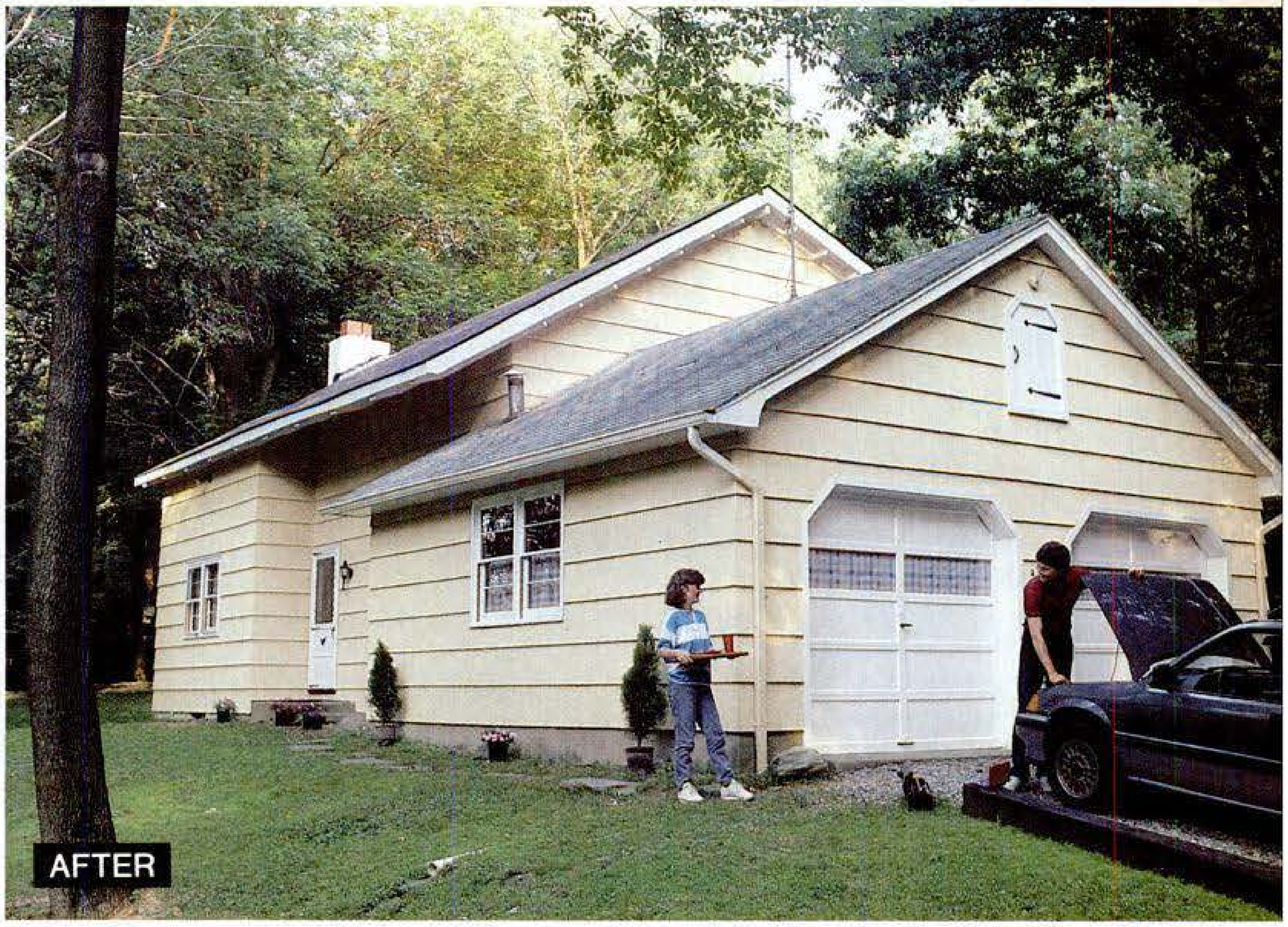
Continued

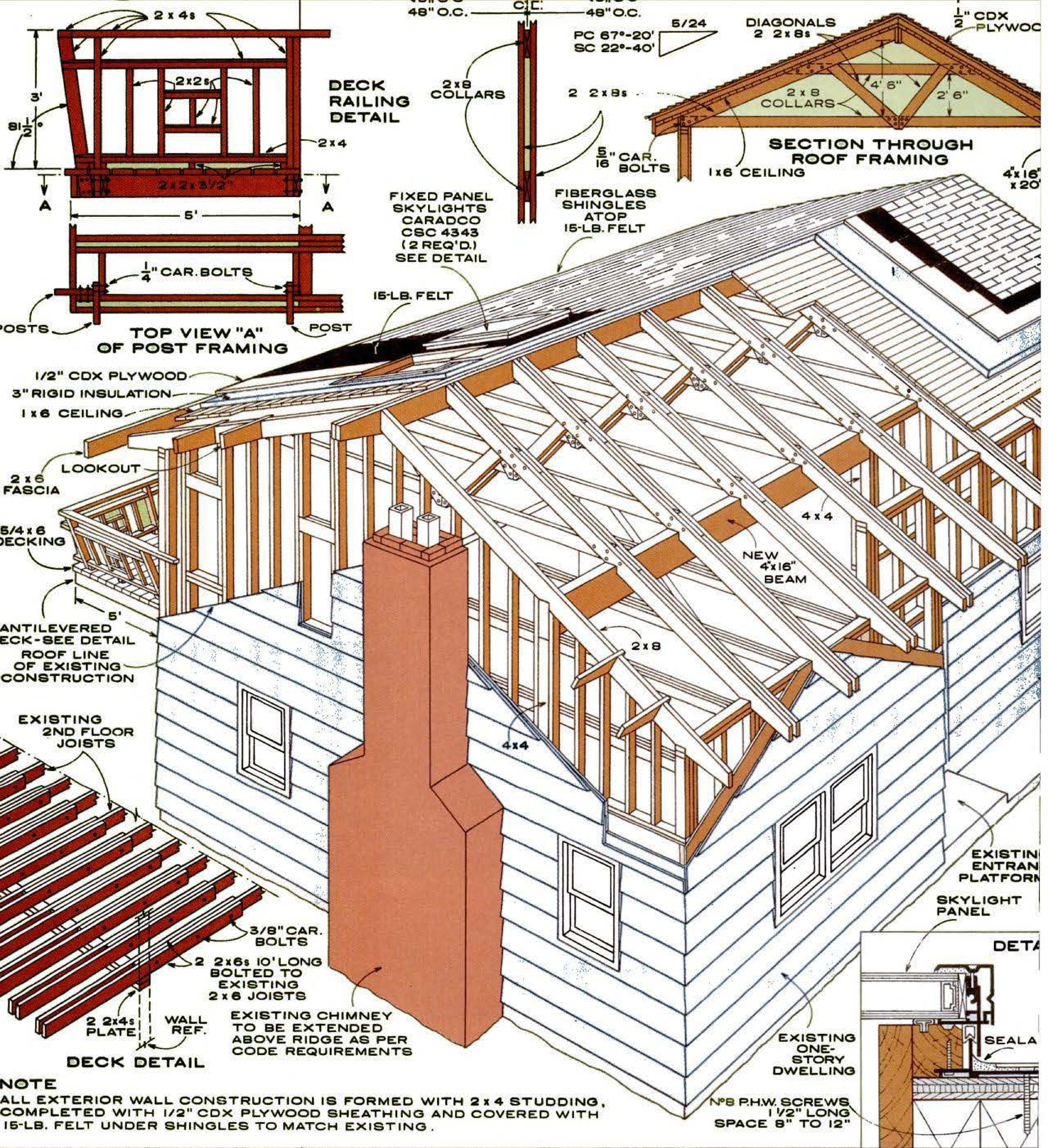


COLOR PHOTOS BY GREG SHARKO

Original ranch (below) had an offset gable incorrectly spliced into the roof—it was beginning to sag. The renovated house has cleaner, more modern lines (right and above); the cantilevered balcony and asymmetrical roof provide architectural interest. Poor siting left the living room (double windows to left in photo below) facing north, with no natural lighting. Caradco skylights and glass door on south side (above) flood the living room (on opposite side of house, lower floor) with light.



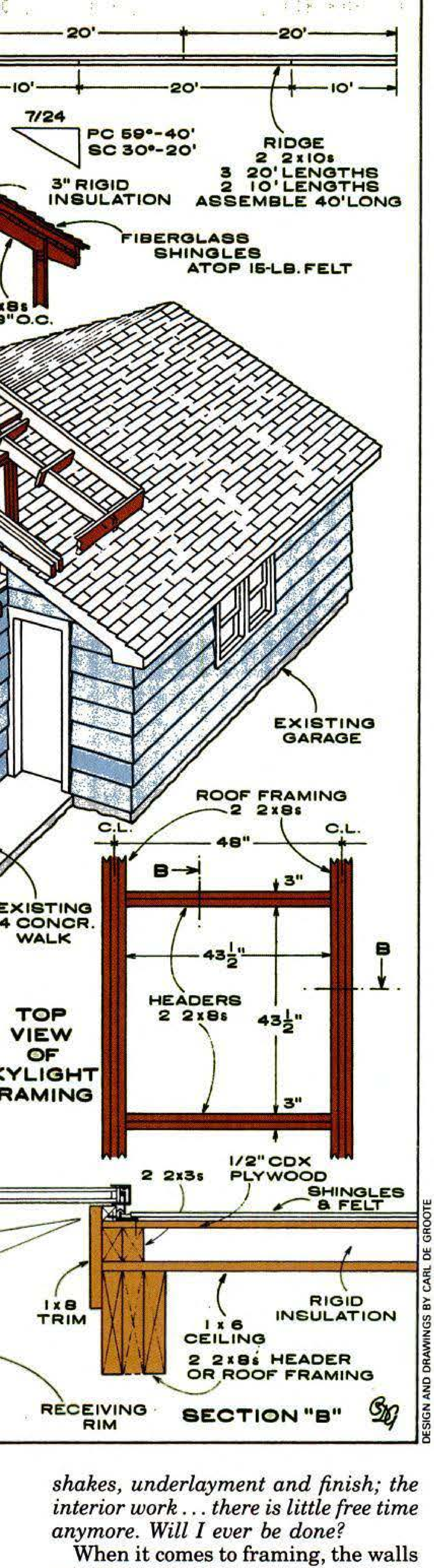



2 x 4s
3'
81½°
2x2s
DECK RAILING DETAIL
2x4
2 x 2 x 3/2"
A
A
5'
¼" CAR. BOLTS
POSTS
POST
TOP VIEW "A" OF POST FRAMING
48" O.C.
C.C.
48" O.C.
2x8 COLLARS
5/24
PC 67°-20'
SC 22°-40'
2 2x8s
5/16" CAR. BOLTS
DIAGONALS 2 2x8s
½" CDX PLYWOO
2 x 8 COLLARS
4' 6"
2' 6"
SECTION THROUGH ROOF FRAMING
1x6 CEILING
4"x16" x 20'
FIXED PANEL SKYLIGHTS CARADCO CSC 4343 (2 REQ'D.) SEE DETAIL
FIBERGLASS SHINGLES ATOP 15-LB. FELT
15-LB. FELT
1/2" CDX PLYWOOD
3" RIGID INSULATION
1x6 CEILING
LOOKOUT
2x6 FASCIA
5/4 x 6 DECKING
5'
ANTILEVERED ECK-SEE DETAIL
ROOF LINE OF EXISTING CONSTRUCTION
4 x 4
NEW 4"x16" BEAM
2x8
4x4
EXISTING 2ND FLOOR JOISTS
3/8" CAR. BOLTS
2 2x6s 10' LONG BOLTED TO EXISTING 2x6 JOISTS
2 2x4s PLATE
WALL REF.
DECK DETAIL
EXISTING CHIMNEY TO BE EXTENDED ABOVE RIDGE AS PER CODE REQUIREMENTS
EXISTIN ENTRAN PLATFORM
SKYLIGHT PANEL
DETA
SEALA
EXISTING ONE-STORY DWELLING
No8 P.H.W. SCREWS 1 1/2" LONG SPACE 8" TO 12"
NOTE
ALL EXTERIOR WALL CONSTRUCTION IS FORMED WITH 2x4 STUDDING, COMPLETED WITH 1/2" CDX PLYWOOD SHEATHING AND COVERED WITH 15-LB. FELT UNDER SHINGLES TO MATCH EXISTING.

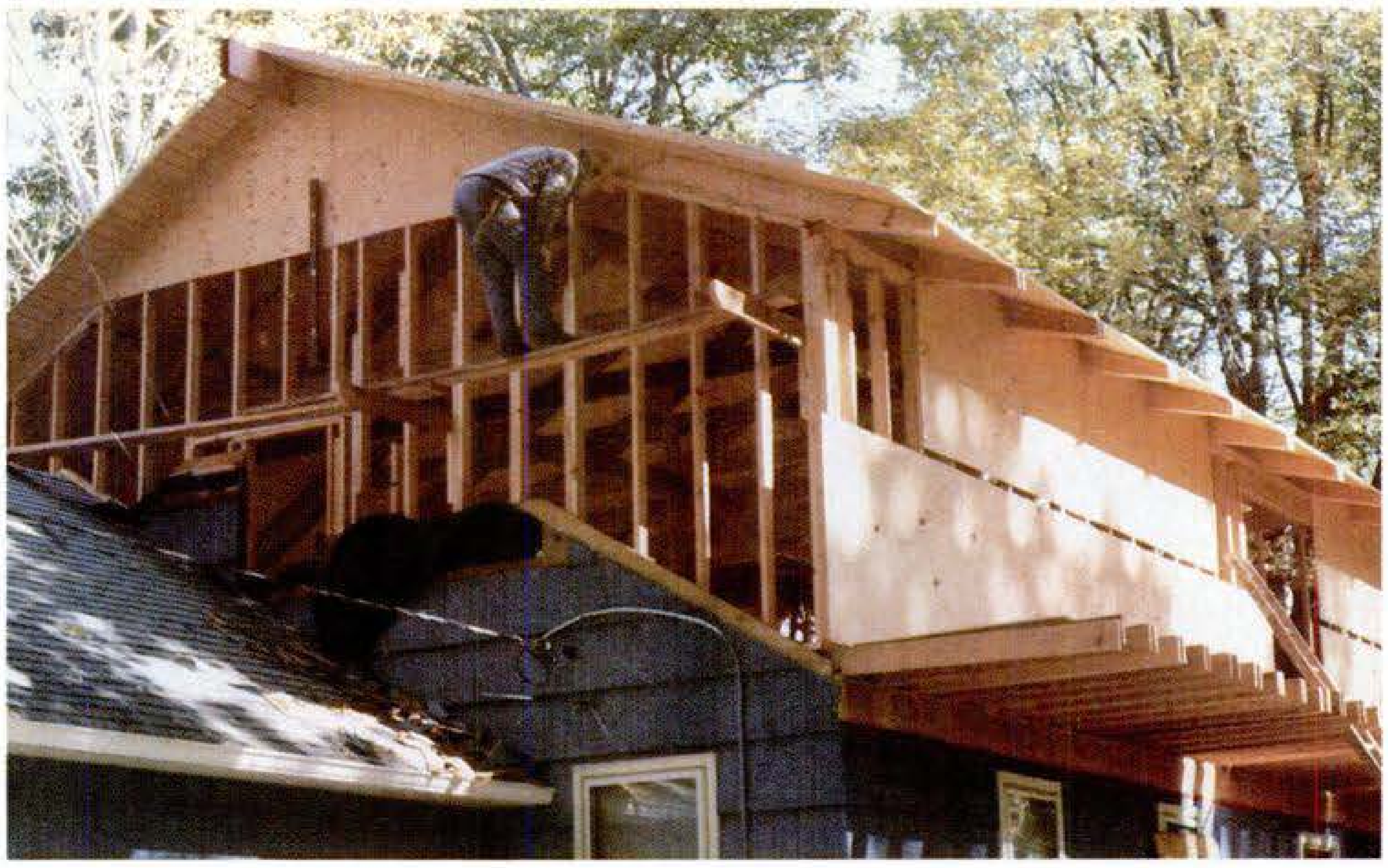
of the addition would require head room of at least 7½ feet at the end wall. But I wanted to minimize the height of the ridge. Since a portion of the north side would be open air space over the living room and head room wasn't as critical, we used an asymmetrical roof design—the pitch is shallower on the south side than on the north. Also, one of my primary goals was daylighting for the living room, so we put two large skylights on the south side. Because the house is in the Northeast, where winters are cold, the rest of the windows in the addition are smallish, and there are none on the north side.

Once you have drawings, you can submit them to local authorities for a permit. Then you can get to work.

A week of 14-hour days sees us complete the framing and roof decking, but it is many more days before the roof is weathertight. A tarp helps me withstand a few rainstorms with only minor leaks—and no damage. The days fade into weeks, the weeks into months. Occasionally I get help from my father or my brother or my brother-in-law, but most of the work I do myself, mostly on weekends—insulating, sheathing, and shingling the roof; siding the house with a double layer of cedar


20'
20'
10'
20'
10'
7/24
PC 59°-40'
SC 30°-20'
RIDGE
2 2x10s
3 20' LENGTHS
2 10' LENGTHS
ASSEMBLE 40' LONG
3" RIGID
INSULATION
FIBERGLASS
SHINGLES
ATOP 15-LB. FELT
8s
"O.C.
EXISTING
GARAGE
ROOF FRAMING
2 2x8s
C.L.
C.L.
48"
B
3"
EXISTING
4 CONCR.
WALK
43½"
B
HEADERS
2 2x8s
43½"
TOP
VIEW
OF
YLIGHT
RAMING
3"
1/2" CDX
PLYWOOD
2 2x3s
SHINGLES
& FELT
1x8
TRIM
1x6
CEILING
RIGID
INSULATION
2 2x8s HEADER
OR ROOF FRAMING
RECEIVING
RIM
SECTION "B"

DESIGN AND DRAWINGS BY CARL DE GROOTE



PHOTOS BY THE AUTHOR

Framing should tie in with original (top). Unforeseen circumstance: Garage roof juts into living space (right); we framed around it. Laminated beam (above) is framed into two sidewalls. Note: We used blocking instead of birdsmouthing rafters as in the drawing.

shakes, underlayment and finish; the interior work . . . there is little free time anymore. Will I ever be done?

When it comes to framing, the walls should match the existing framework, in this case 2 × 4s. You can either rip out all old framing down to the top sill and frame the upper level anew, or, leaving the gable ends, tie into the old framing and cut down on waste. We chose the latter. The roof is an exposed-beam truss design, using double 2 × 8s 48 inches on center. All 2 × 6 floor joists are either doubled or tripled, depending on span, and the double joists for the cantilevered deck sandwich the existing floor joists and extend five feet into the house. The deck is made from California Redwood Assn. redwood.

An eight-foot Caradco patio door opens onto the long five-foot-wide balcony/deck with a beautiful view of our wooded property. I used 5/4 × 6 clear redwood for the decking; the double joists provide ample strength so 2 × 6 decking isn't needed, and I get a knot-free deck surface. The railing, made from 2 × 4s and 2 × 2s, is based on a four-foot modular design of my father's, with no space more than 6½ inches wide. The design avoids the boring ladder look of many deck railings, and it is pitched out slightly to provide maximum deck space.

An important part of the project design is the 4-by-16-inch exposed laminated beam traversing the width of the living room. This supports the long span of the roof over the open living-room area. The roof is covered with three inches of Energy Shield rigid insulation from Owens-Corning Fiberglas; conventional fiberglass batts are used in the walls. I sheathed the roof and walls with ½-inch plywood and used Owens-Corning Chaparral II shingles on the roof. The exterior walls are sided with conventional striated cedar shakes to match the existing siding. Finally, the entire house was primed and painted beige (Richmond Bisque from Benjamin Moore).

It's been tough, sure, but was it worth it? As I relax on the finished deck, watching my son play and feeling the cool summer evening breeze, I think of the wisdom of the old sports adage: no pain, no gain.

LIST OF MANUFACTURERS

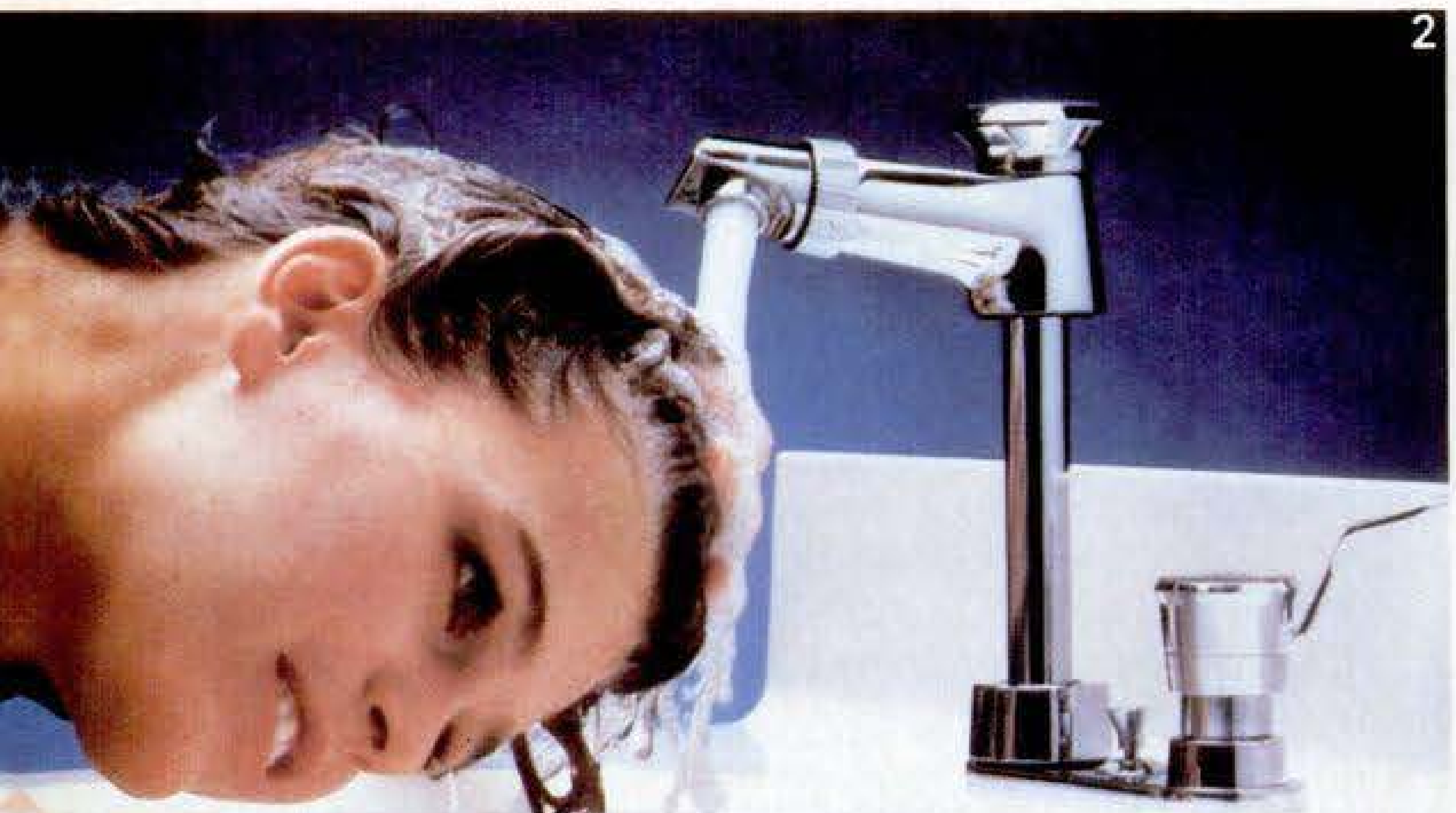
The following manufacturers were selected for participation in this project. For more information, write to source: **California Redwood Assn.**, 591 Redwood Hwy, Mill Valley CA 94941; **Caradco Corp.**, Box 920, Rantoul IL 61866; **Benjamin Moore Paint Co.**, 51 Chestnut Ridge Rd., Montvale NJ 07645; **Owens-Corning Fiberglas Corp.**, Fiberglas Tower, Toledo OH 43659

AMERICAN STANDARD

1

Fabulous faucets

The lowly water tap has blossomed into a high-tech, high-design item for the modern house. One tells you the water temperature; another rises to the occasion; one turns on and off without a touch; yet another spigot spouts a spectral waterfall; still others look more like objets d'art than merely functional faucets.



2

3

4

By STEVEN ASHLEY

1 Before you test the water, American Standard's Ceramix Electronix faucet displays the water's temperature on a solar-powered digital readout. The faucet has a ceramic disc valve cartridge instead of conventional washers. $295.

2 Moen's Legend Lavatory Riser lifts over 7 in. to fill tall orders such as a vase or watering can. The spout also rotates upward to form a drinking fountain. The chrome-finished faucet has a replaceable cartridge with a stainless-steel piston. Price: $138.

3 When your hand intercepts the infrared beams emitted by the Cue-Tel T-100C faucet, the water flows. Remove your hand, and the water stops. The $300 faucet operates on 12-volt DC; Columbia Electronic Research makes it.

4 The $340 Water Rainbow fill spout is one of three easy-to-install kits from Jacuzzi that fit most whirlpools, baths, or spas. Cascading sheets of water create a multicolored display.

5 Graceful curves make Kohler's Cygnet (K-6762) faucet stand out in any crowd. The brass faucet has washerless ceramic valving and black-chrome plating accented by gold and brass. $464.

6 Porcher's Agate brass kitchen tap features a durable epoxy finish in red. The $515 faucet includes a ceramic disc cartridge, 90°-rotation handles, and a spray fixture (not shown).

7 The Børmix 80 faucet from Abbaka has separate water-flow and -temperature regulators for easy adjustment. The brass faucet is covered with powder-coat white epoxy enamel. $250.

5

FAUCET FABRICATORS

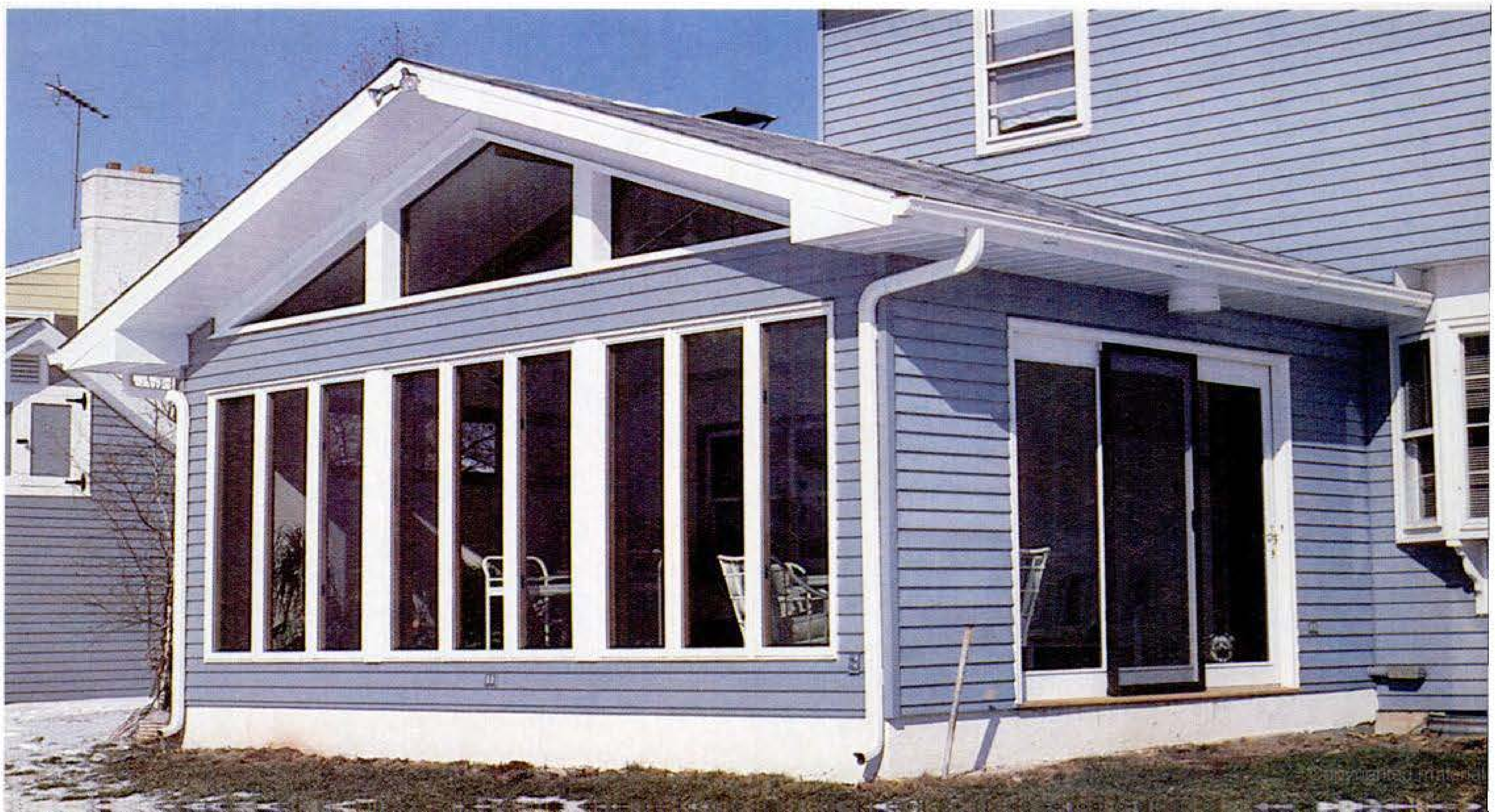
Abbaka, 435 23rd St., San Francisco CA 94107; **American Standard, Inc.,** 40 W. 40th St., New York NY 10018; **Columbia Electronic Research Group Ltd.,** 50 Doughty Blvd., Lawrence NY 11559; **Jacuzzi Whirlpool Bath,** 298 N. Wiget Lane, Walnut Creek CA 94596; **Kohler Co.,** Kohler WI 53044; **Moen Group (Stanadyne Inc.),** 377 Woodland Ave., Elyria OH 44036; **Porcher Inc.,** 612 N. Michigan Ave., Chicago IL 60611

6

7

A spa in the sun

A plant-filled spa room is a wonderful place for enjoying the bubbly (above). Fixed windows and a sliding glass door are placed at the southern and eastern exposures to gain warmth from the winter sun (below), and the tiled slab stores heat for release in the evening. Solar gain is so effective that heat can be blown into the adjacent house to cut fuel costs. Overhangs at the eaves and gables prevent summertime overheating by shading the room from the midday sun.



This homeowner chopped through an unused patio slab to sink a spa, then erected a sunspace around it. Solar design and special insulating features keep it energy efficient—even when there's snow outside.

By NAOMI J. FREUNDLICH

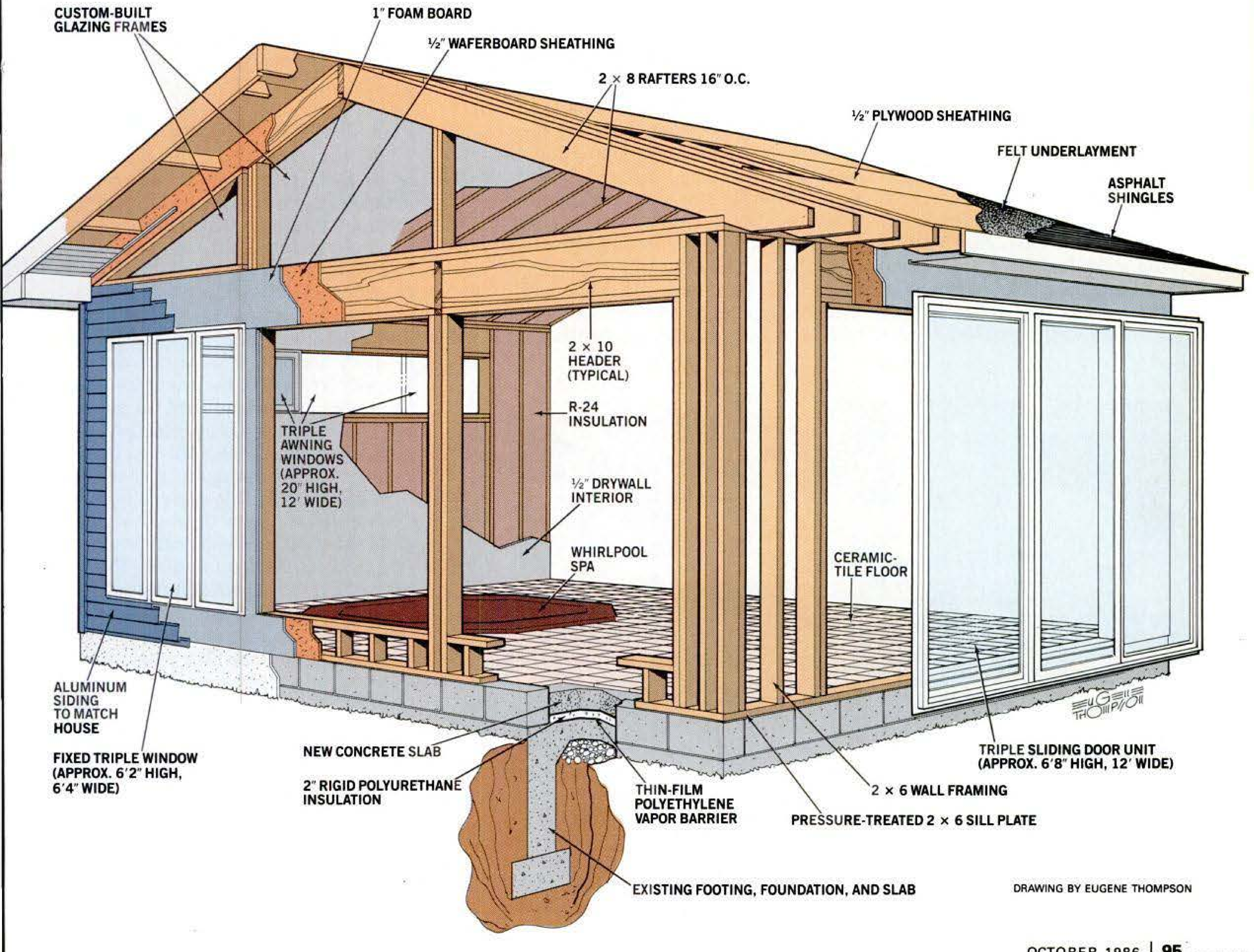
One early summer day, a Pennsylvania homeowner and his wife stepped out onto their drab concrete patio slab and began thinking about improvements in their lifestyle. Several months and much sawing and hammering later, they stepped out onto the same spot, but this time lowered themselves into a bubbling spa tub surrounded by tile and plants and sunny windows. As snow fell outside, they could hardly remember the dull slab that used to be.

Going from a useless "contractor's basic" to this kind of luxury was not problem-free. The homeowners wanted the spa addition to be on the same level as the existing ground floor of their house, but the old patio slab was a step down from the house. Also, the house was cantilevered at the second floor, and the spa room would have to be tucked under this overhang with an interior soffit. Lastly, although the homeowners wanted to use the spa year-round, they didn't want it to add to their heating load.

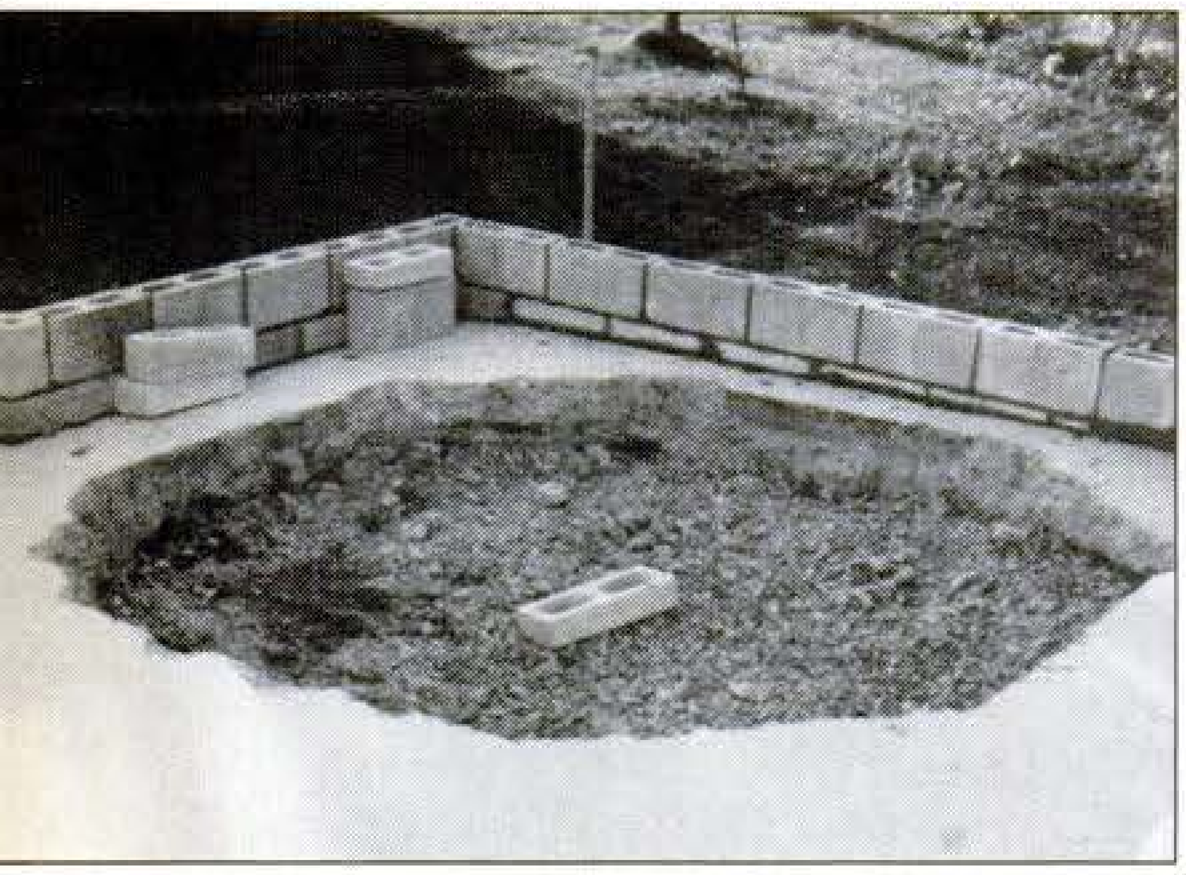
The solution to the first problem turned out to help achieve the last requirement. To make the addition level, the homeowners decided to pour another concrete layer. First they built a concrete block wall on the original patio as a form for the new slab. Then, using a concrete saw, he chopped a hole through the existing slab to take the spa he'd bought. The old slab was covered with a plastic vapor barrier, and on top of the barrier, he placed two inches of rigid-foam insulation. After he'd leveled this new surface, the second concrete layer was poured. When it had set and the spa was in place, the surface was tiled. The resulting floor doubles as a heat sink that adds significantly to the passive-solar design. The ½-inch-thick earth-tone tiles that cover the concrete capture heat while the sun shines on them, and hold it in the room. The tiles (from American Olean Tile, Lansdale, Pa. 19446-0271) aren't glazed, so they also provide some slip resistance. And because they're a solid color all the way through, they won't develop wear patterns.

Though the homeowners knew pas-

Continued


CUSTOM-BUILT GLAZING FRAMES
1" FOAM BOARD
½" WAFERBOARD SHEATHING
2 × 8 RAFTERS 16" O.C.
½" PLYWOOD SHEATHING
FELT UNDERLAYMENT
ASPHALT SHINGLES
2 × 10 HEADER (TYPICAL)
R-24 INSULATION
TRIPLE AWNING WINDOWS (APPROX. 20" HIGH, 12' WIDE)
½" DRYWALL INTERIOR
WHIRLPOOL SPA
CERAMIC-TILE FLOOR
ALUMINUM SIDING TO MATCH HOUSE
FIXED TRIPLE WINDOW (APPROX. 6'2" HIGH, 6'4" WIDE)
NEW CONCRETE SLAB
2" RIGID POLYURETHANE INSULATION
THIN-FILM POLYETHYLENE VAPOR BARRIER
TRIPLE SLIDING DOOR UNIT (APPROX. 6'8" HIGH, 12' WIDE)
2 × 6 WALL FRAMING
PRESSURE-TREATED 2 × 6 SILL PLATE
EXISTING FOOTING, FOUNDATION, AND SLAB

DRAWING BY EUGENE THOMPSON



The hole for the spa was cut with a concrete saw through the original patio (above). Before pouring the second layer, a wooden mold was erected around the hole. Rigid foam applied over sheathing is covered with aluminum siding.

sive-solar design was a good choice for their spa room, they were surprised to find that after construction was completed, their heating bills for the entire house dropped by almost 20 percent. They attribute this drop to several factors. The spa room is well insulated; according to the homeowners, the ceiling has an insulation value of R-36. This was obtained by using 2 × 12s in the construction and stuffing 11-inch fiberglass batts between them. The walls are constructed from 2 × 6 studs and filled with six-inch fiberglass insulation. Waferboard was nailed down on the studs, providing the structural strength for the roof support, then this sheathing was covered with foil-faced inch-thick polyurethane foam. This added insulation brings the wall R-value up to 24. The walls, as well as exposed wood such as the window headers, are faced with aluminum siding for easy maintenance—and to match the existing house.

In line with this passive-solar design, fixed gable windows are framed in the southern wall. All windows —both the custom models and commercial units—are double glazed to help hold heat in the room. The western exposure has only three small, high windows for ventilation. The roof overhangs 18 inches on all three sides; the homeowners say this shades the sun room in the summer like the brim of a hat, avoiding overheating and the need for extra air conditioning. In the winter, when the sun is lower in the sky, the overhang does not impede warming rays.

But perhaps one of the most important energy-saving aspects of this sun room is tucked into the interior soffit. When the sunspace temperature creeps above 75 degrees F, a thermostat-controlled fan built into the soffit switches on. Heat is carried out of the spa room through a duct running within the soffit and into the main house through a wall grille. Although the homeowners installed hot-water baseboard heating in the spa room, they rarely have to use this heat.

Two ways to tub heat loss

The spa tub itself is heavily insulated against heat loss, too. Before pouring the second concrete slab, the contractor built a wooden form around the hole chopped through the original slab. The tub, which had been factory-sprayed with urethane to prevent heat loss, was set into the hole and plumbed, then backfilled with sand. A separate gas heater outside the western wall of the sunspace heats the water for the spa, and all electrical controls are GFI-protected. The pumps and blowers for the spa are located in this same outdoor shed. For convenience, the water pipes run out to this pump house through a chase molded into the second concrete layer. According to the homeowners, this arrangement cuts down significantly on noise in the spa room. It also makes the plumbing easier to get to—no need to break up the floor when there's a leak or other problem. Also, in the interest of convenience, the underwater tub lights are not ordinary low-voltage pool bulbs. Instead, the bulbs are located in the pump house, and fiber-optic cables running through the plumbing chase bring light to special lenses in the tub. When a bulb goes out, it's easy to replace.

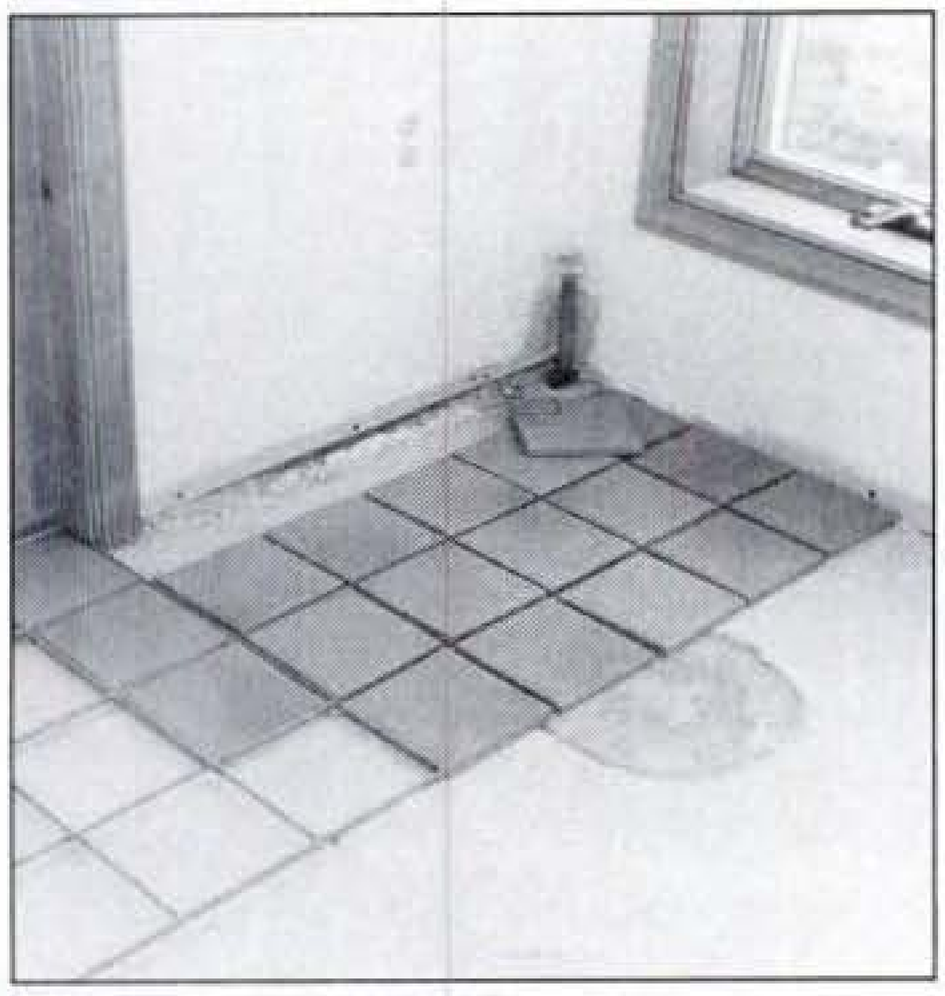
In the end, the homeowners have found that their versatile addition can

Continued

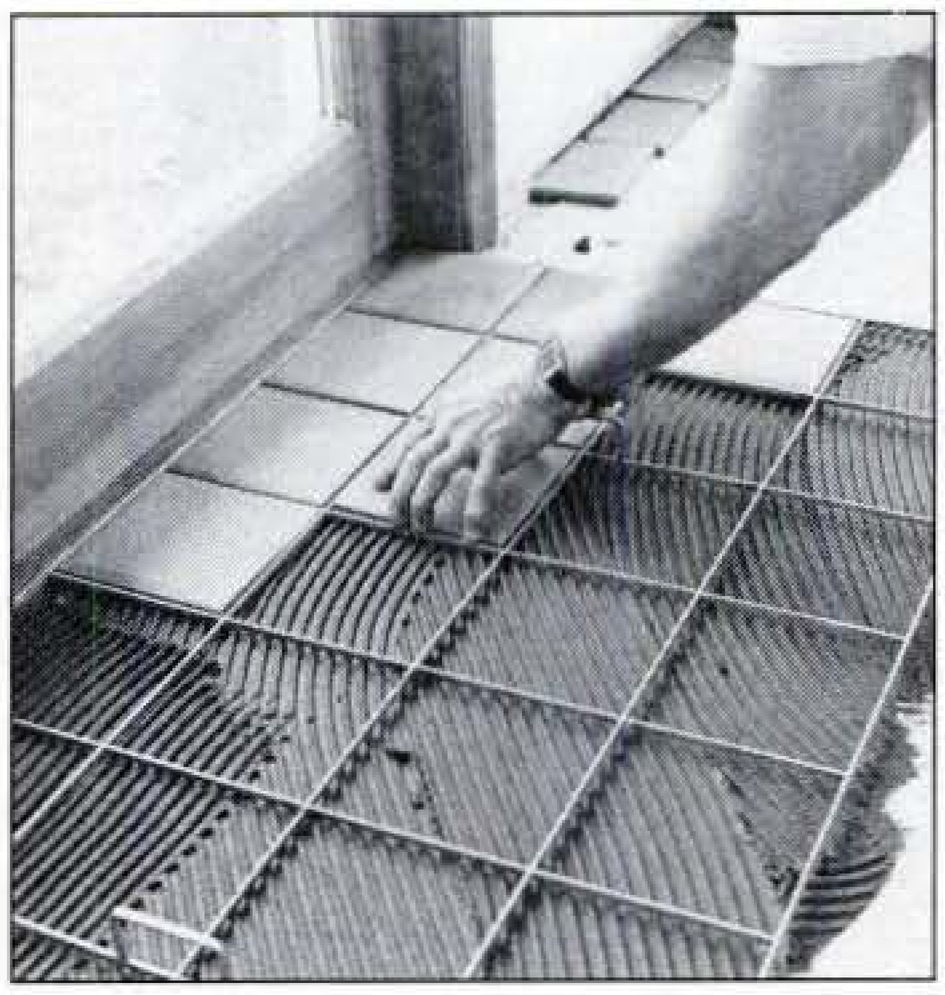
Sun-filled spa room doubles as a casual all-season dining or entertaining area.

be used for more than just water sports. Features like the ceiling fan and cathedral ceiling with exposed beams and track lighting over the spa make the room an attractive sun porch and party room. The aluminum siding was removed from the old south wall of the house, and this surface—now an interior wall—was refinished. The homeowners added a patio dining set, so their sunny spa doubles as an airy breakfast room.

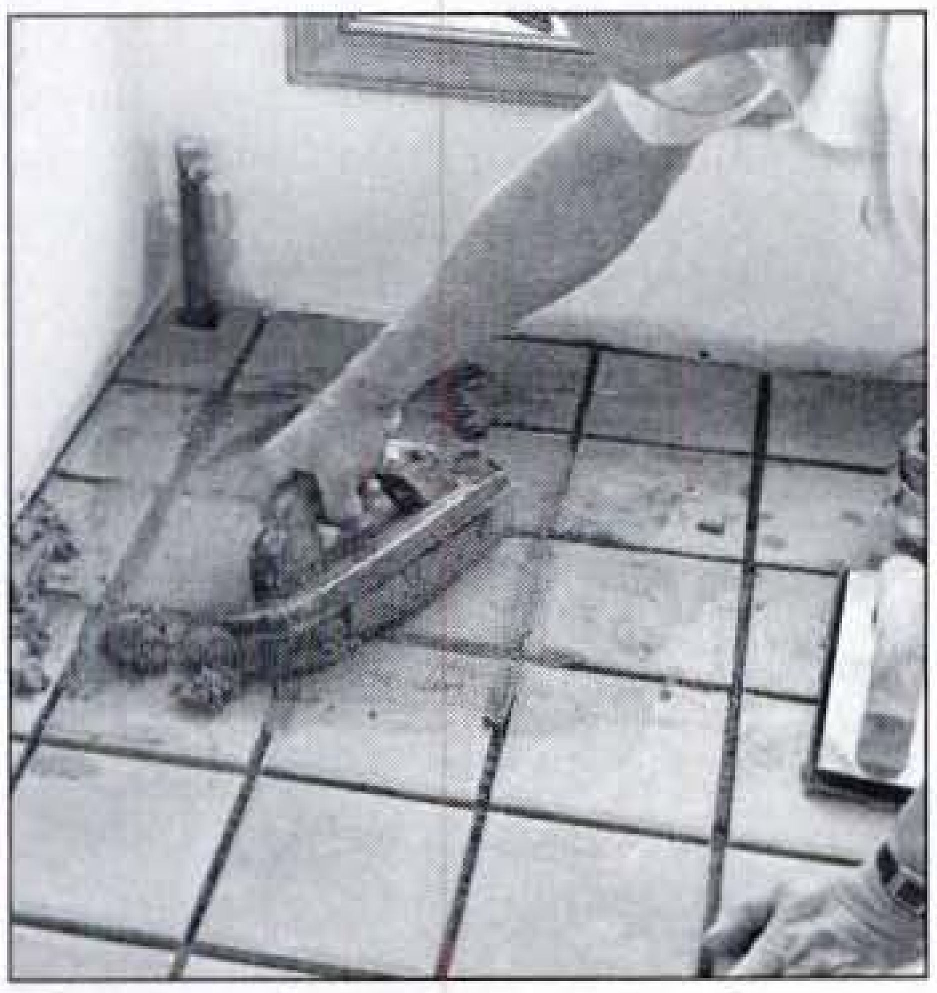
Follow these fast new tiling tips



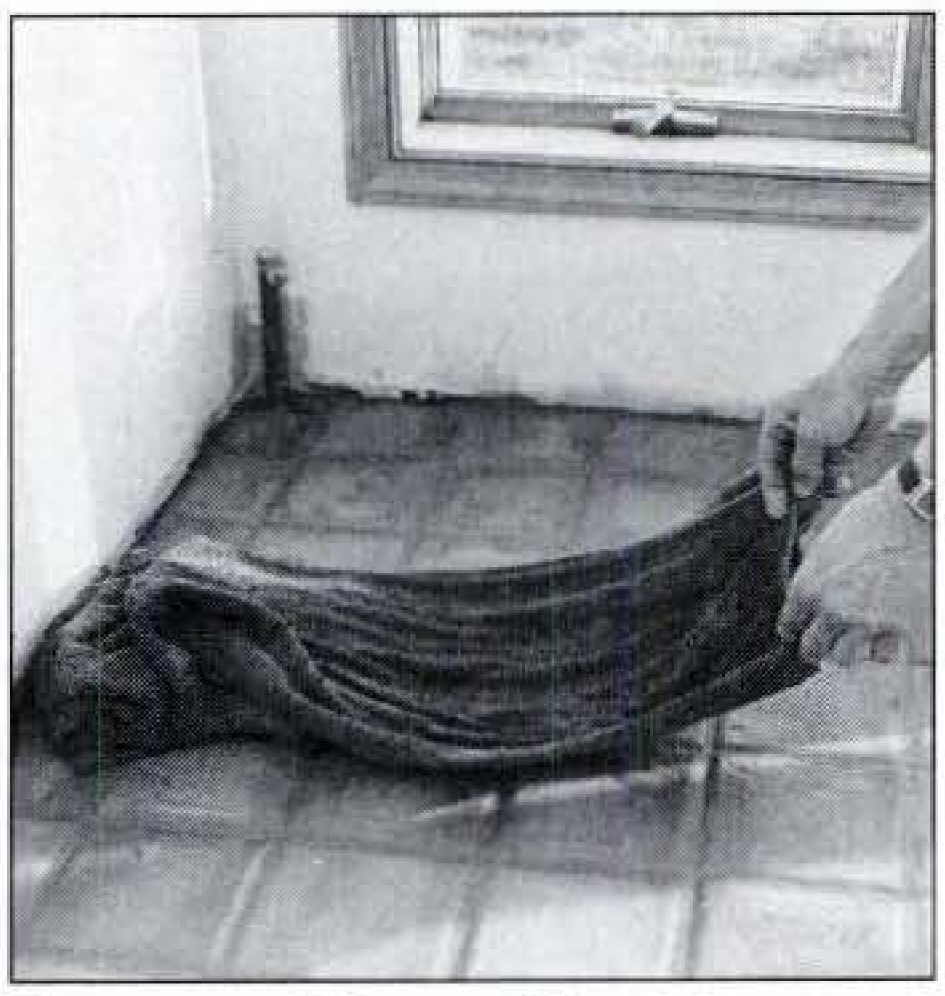
Lay tile out in rented metal frame to determine best placement for trimming. Spread mortar with flat side of trowel.



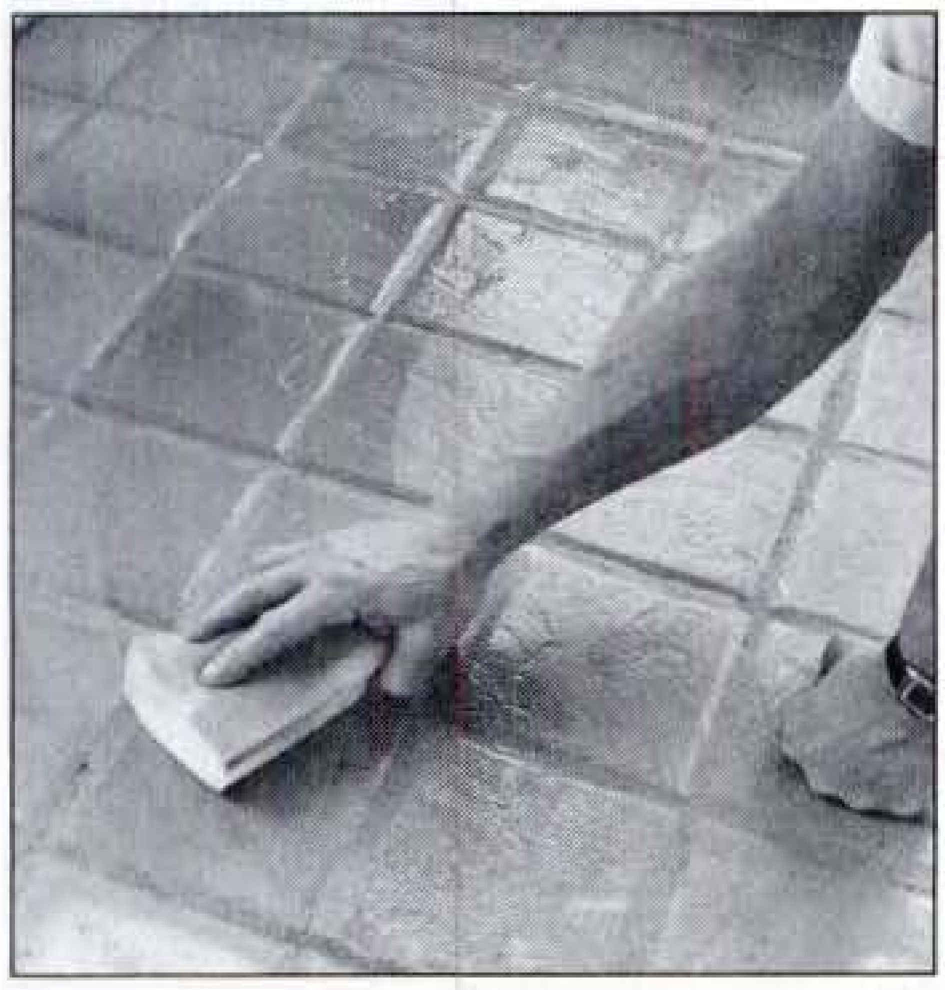
Comb adhesive with notched side of trowel; use a frame to place tiles. Seat tile by striking with a wood block.

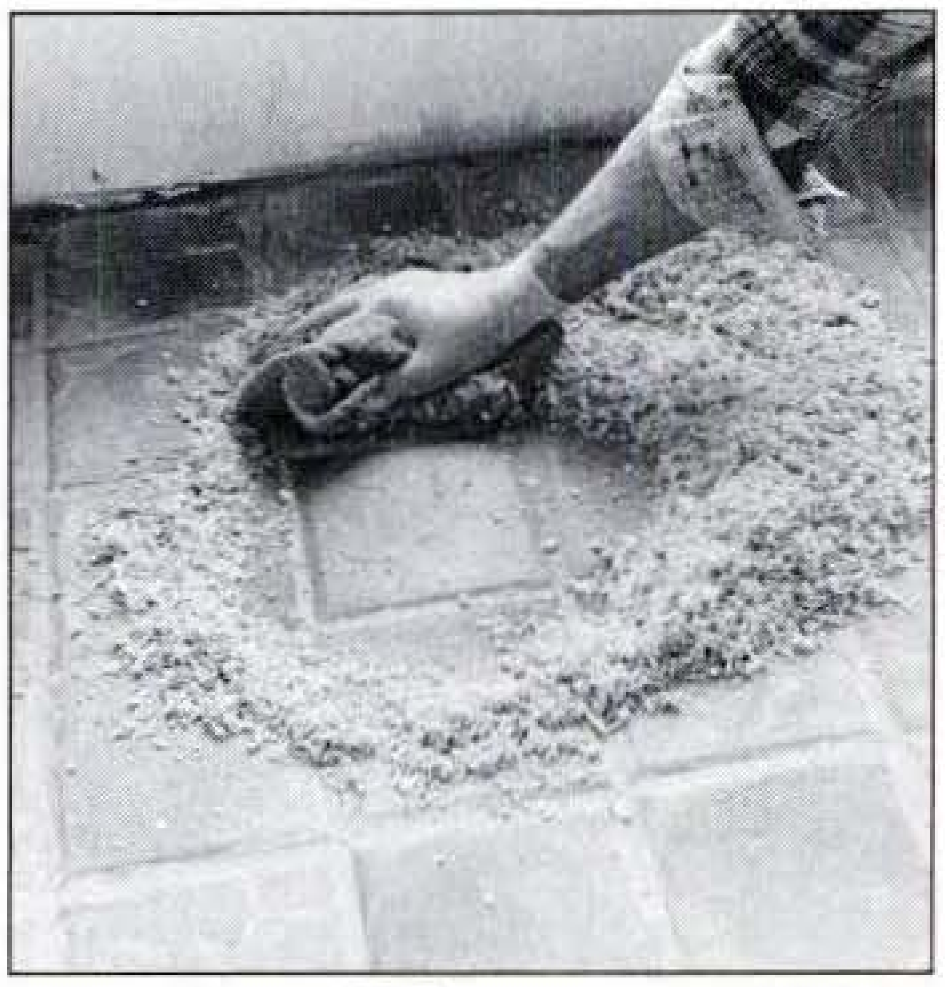


The next day, after mortar has set, spread grout diagonally; force it into joints with rubber-faced trowel.



Drag a towel damp with a latex grout film remover and water solution across the surface of set tile.





"Dress" joints with damp sponge. If grout residue remains, mix softwood sawdust with water and 5% acid, using gloves. Make sure grout joints are set, then rub the mixture over the tile with a dry towel.

NIMSLO
3D
Compact! Just 5⅜" Long.

COMB
Authorized Liquidator

35mm 3-D CAMERA
LIQUIDATION PRICED!

- Get 18 3-D Color Prints from 36-Exposure Roll of Film.
- 4 Separate Lenses Take 4 Separate Shots. Special Processing Produces a SINGLE 3½" x 4½" Color Print!
- Uses Standard 35mm Color Print Film.
- Fully Automatic. Just Aim & Shoot.
- Automatic Shutter Speed Control From 1/30 to 1/500 Second.
- Quadra Lens System. Four 30mm f/5.6 Air-Spaced Triplets with Coated Optical Glass.
- Built-In Double Exposure Prevention.
- 3-D Processing Available from a Connecticut Firm.

Even if you own a Nikon, Canon or Pentax...none of them can do what THIS unique camera does! And now, thanks to a special transaction with a trading company, you can buy this factory new, first quality Nimslo™ 3-D Camera at a **LOW liquidation price!**

Discover the incredible realism of 3-dimensional photography now at tremendous savings!

60-Day Limited C.O.M.B. Warranty.

Compare At........ $189.00

Liquidation Price........... $39

Item H-1559-5242-003 Ship, hand: $4.50 ea.

Credit card customers can order by phone, 24 hours a day, 7 days a week. VISA MasterCard AMERICAN EXPRESS

Toll-Free: 1-800-328-0609

Sales outside the 48 contiguous states are subject to special conditions. Please call or write to inquire.

SEND TO: **Item H-1559**
C.O.M.B. Direct Marketing Corp.
1405 Xenium Lane No./Minneapolis, MN 55441-4494

Send__**3-D Camera(s)** Item H-1559-5242-003 at $39 each plus $4.50 each for shipping, handling. (Minnesota residents add 6% sales tax. Sorry, no C.O.D. orders.)

☐ My check or money order is enclosed. (No delays in processing orders paid by check).

Charge: ☐ VISA® ☐ MasterCard® ☐ American Express®

Acct. No.____ Exp.__/__
PLEASE PRINT CLEARLY
Name ____
Address ____
City ____
State ____ ZIP ____
Phone (___) ____
Sign Here ____

COMB COMB COMB

Introducing
The Rascal Front Runner

Medicare
Approved

Our most affordable
electric 3-wheeler

Compact and portable so you can take it anywhere. Features one-hand controls, battery charger, lightweight parts and more. Medicare and private insurance reimbursable. Priced below most other front wheel drive 3-wheelers. 30 day money back guarantee. Call or send coupon for free color brochure. 1-800-662-4548.

Electric Mobility Corp. Dept. 1734
1 Mobility Plaza, Sewell, NJ 08080

Name ____________________
Address ____________________
St ______________ Zip ______
Phone ____________________

cable
tv
DESCRAMBLER PARTS

We stock the exact parts, PC Board and A.C. Adaptor for an article published in Radio Electronics Magazine (Feb., 1984) on building your own CABLE TV DESCRAMBLER.

#701 PARTS PACKAGE $29.95
Includes all the original resistors, capacitors, diodes, transistors, integrated circuits, coils and IF transformers.

#702 PC BOARD $12.95
Original etched & drilled *silk-screened* PC Board used in the article.

#704 AC ADAPTOR $12.95
(14 volts DC @ 285MA)

Both #701 & #702 .... $39.00
#701, 702 & 704 .... $49.00

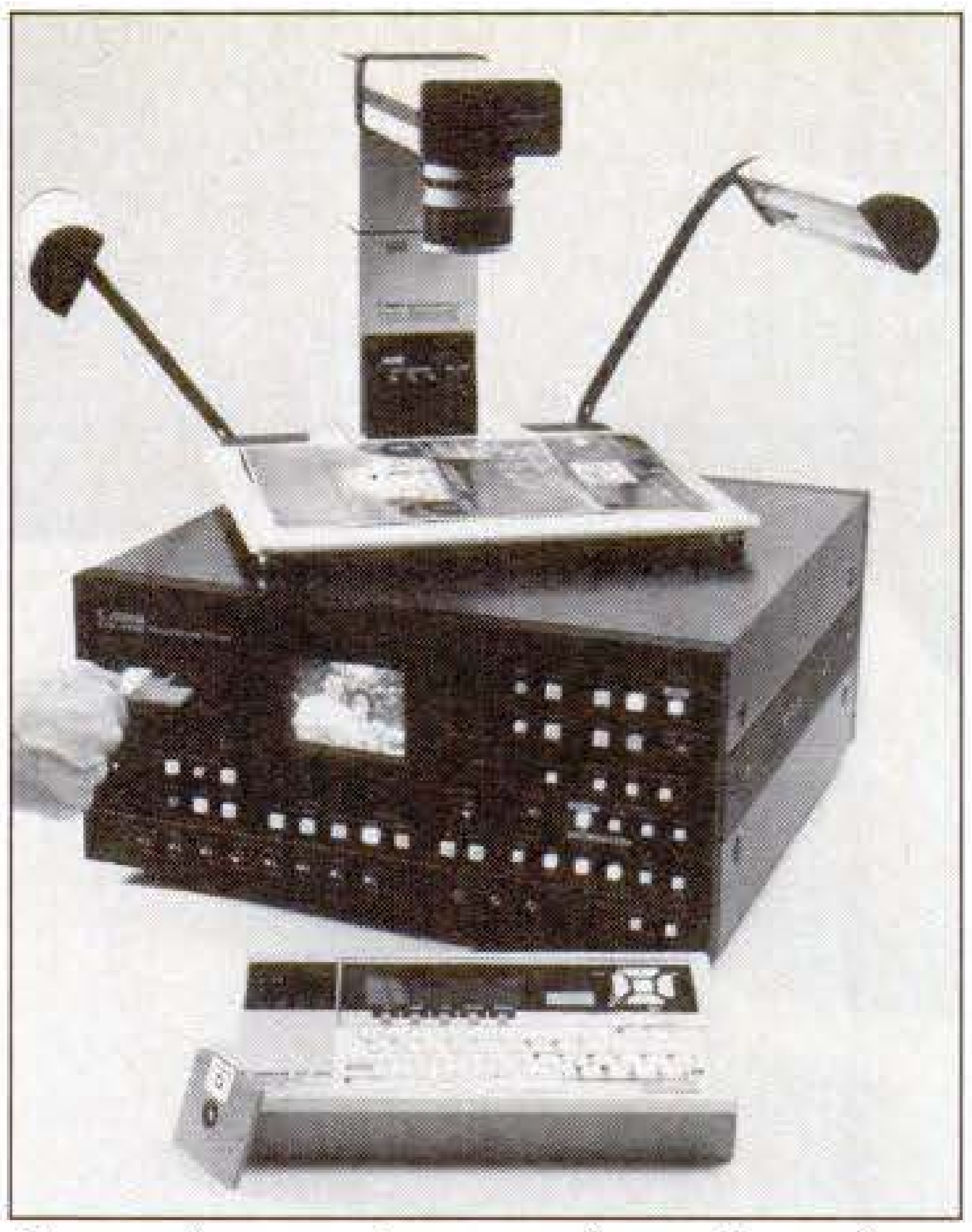
FREE!! Reprint of Radio Electronics Article on Building Your Own Cable TV Descrambler with any purchase.

Add $2.50 Shipping & Handling
$4.50 for Canadian Orders

ORDER TOLL FREE
1-800-227-8529
Visa, MasterCard or C.O.D.

J & W ELECTRONICS, INC.
P.O. Box 800
Mansfield, MA 02048

Video photography [Continued from page 74]



Canon transceiver sends and receives images over phone lines from still-video disks or other sources, such as the separate TV-camera stand atop unit.

ages on a video floppy disk. Since a field has only half the scan lines of an ordinary TV picture or frame, special circuits in the $2,695 recorder fill in the missing lines during playback.

"Canon thought it was better to be able to shoot fifty images, because the resolution is certainly adequate for what you can see on TV," Metz says. The recorder can capture either 25 full-frame or 50 field images from any video source such as a VCR or ordinary TV camera.

Metz waves me to a seventh-floor window to illustrate a special advantage of still video. "See that distant store beyond the trees?" he asks, indicating a tiny building on the horizon. He hands me an ink-jet print made from a telephoto still-video snapshot that clearly shows a red sign in the store's window. "The incredible thing is that's a hand-held shot at 1/25 second with the telephoto equivalent of a 2,400-mm lens," Metz says.

That's a monster lens for conventional cameras, requiring a tripod and good stability to prevent blurring. But Metz achieved it with an ordinary 300-mm lens doubled to 600 mm by a two-power extender. Focal lengths for 35-mm lenses, used with an adapter for the still-video camera, are effectively quadrupled because the CCD is only about one-quarter the size of 35-mm film. A remarkable zoom capability, 11 to 66 mm, is achieved with one of the f/1.2 lenses made for the RC-701.

Eight-color cartridges

Canon's $6,950 printer has an important role in still-video picture fidelity: "If you make a print from a frame image, the printer is capable of giving you a better image than you can see on a TV screen," Metz says. The printer squirts tiny droplets of colored inks. A large print, about three by five inches, takes 4½ minutes to complete. While some carefully crafted prints I saw are eye-catching, they lack the detail of film-based prints.

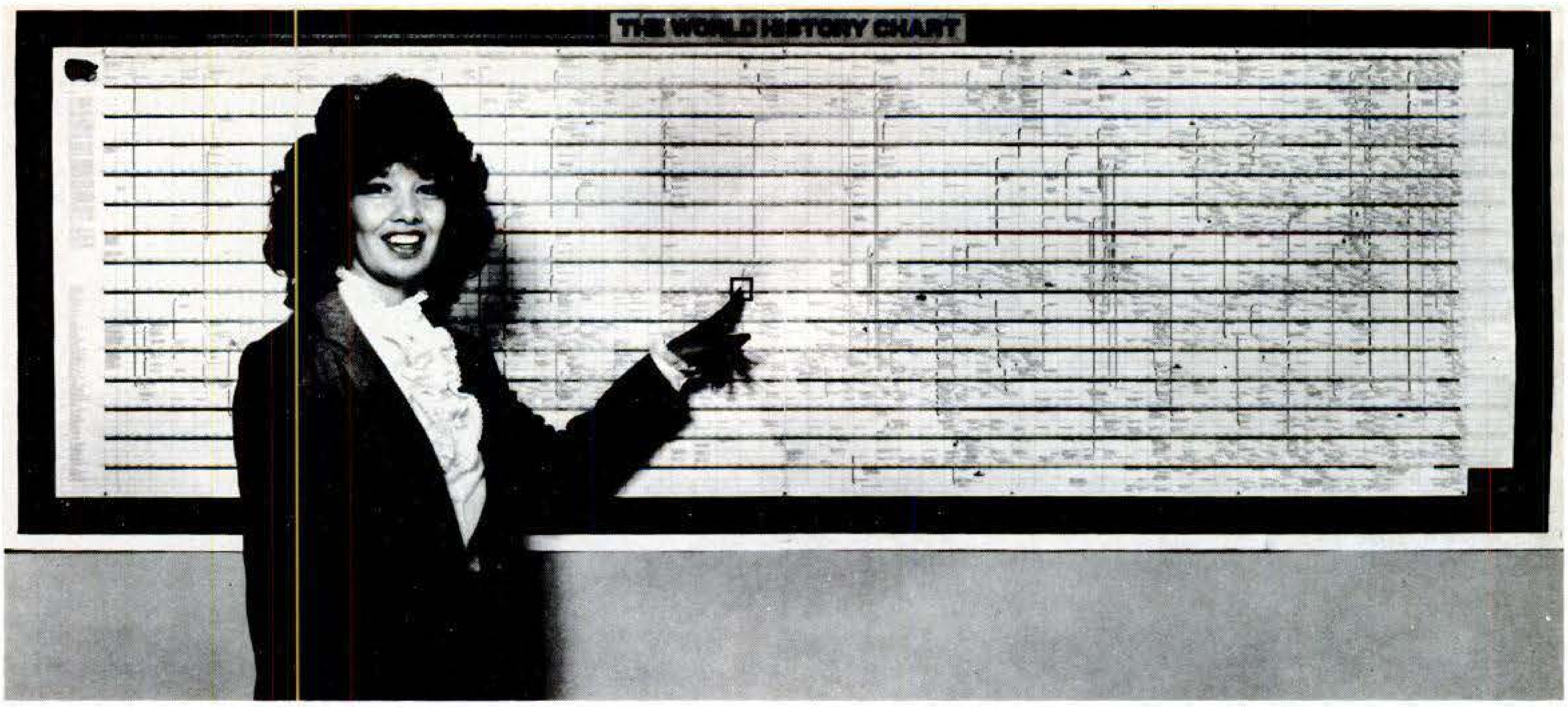
Canon, which revolutionized desktop copiers and laser-based computer printers with plug-in disposable toner cartridges, also devised a clever eight-color ink cartridge for its still-video printer. "The inks are in foil packets; when you install a cartridge, a needle pierces each packet," Metz says, showing me one of the book-size cartridges.

I spot one print on the table with four separate images. That print originated, Metz explains, in the semiconductor memory of the $19,900 transceiver on the table before us. "The purpose of splitting the image is for rapid transmission of multiple images," Metz says, calling up four images from a disk and filling the transceiver's memory and tiny color screen with them. "If you have a photographer in Beirut who has four pictures he thinks are pretty good, he can send four pictures back in one three-minute transmission. An editor in New York might like the top right picture, which could be retransmitted at full size," he adds.

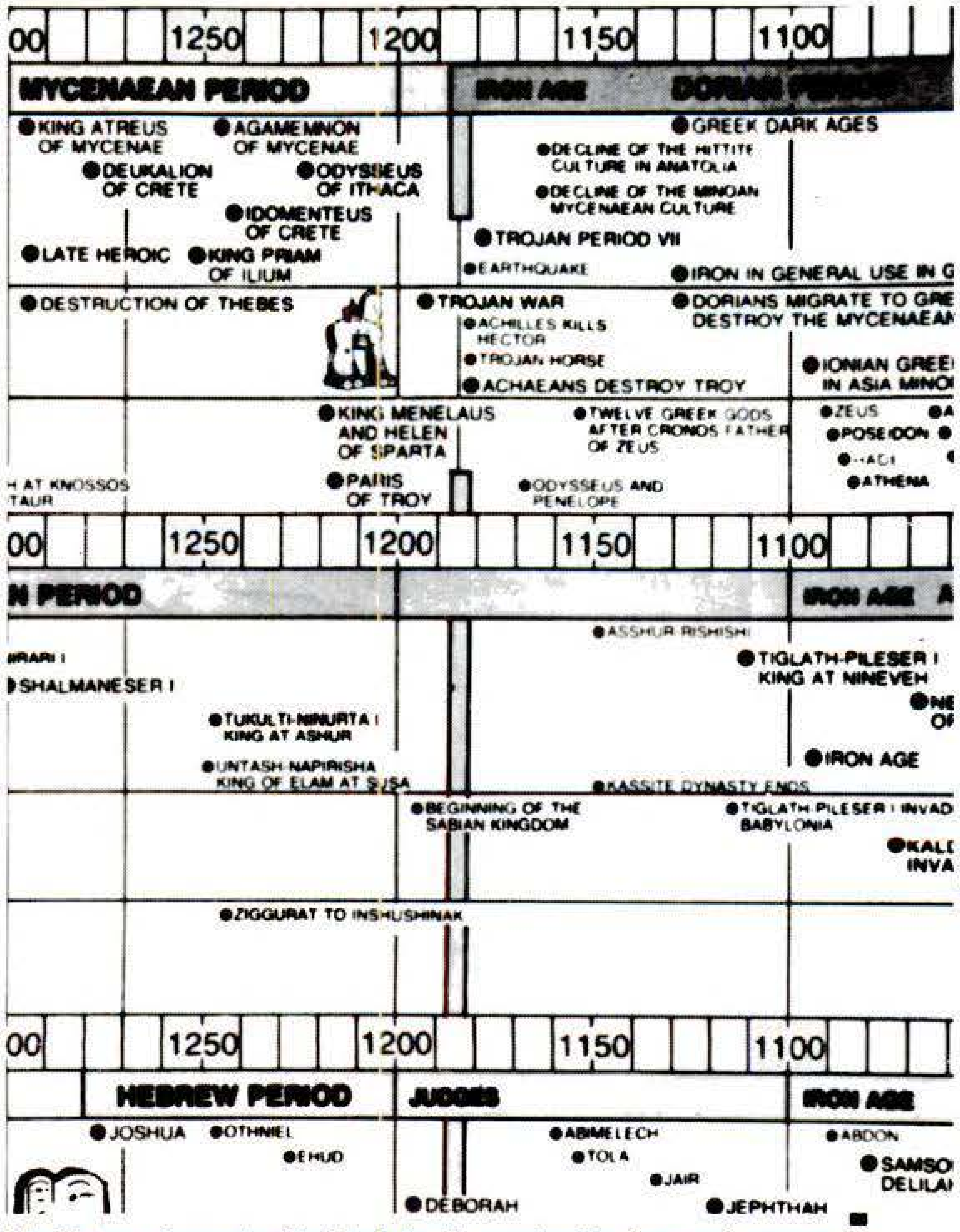
Separating colors

Several days earlier, in Atlanta, I had watched Sony's Bob Bensman demonstrate similar multiple-image capabilities built into his firm's $11,000 Mavigraph printer. "Just select 'split' and 'memory in,'" he said, tapping buttons and merging images on a TV monitor. Minutes later, a 4⅝-by-six-inch print with the same four pictures emerged from the printer. The printer has a special application: For color illustrations, publishers produce a series of color images (called separations) so they can make printing plates for colored inks. With the Mavigraph Plus model, available next year, publishers will be able to produce three- or four-color separations—in the same number of minutes. "Editors will no longer have to wait for prints to be developed, or a color separation that now takes about thirty minutes and several hundred thousand dollars worth of equipment," says Bob Mueller, vice president of new business development at Sony.

Although some of the Canon and Sony equipment is affordable by well-off camera enthusiasts, the gear is aimed at commercial use. Company officials won't say when, but lower-priced gear for consumers is coming. PS



History comes alive. On The History Chart.



The history shown in this block is all contained in the small square indicated on the chart above.

The chart is produced in full color.

If you think history is just a collection of dry facts, you should send for The History Chart today. Because The History Chart (34 inches high and 8 feet long!) is a fascinating 6000 year chronology of the world's people and events to the present day. To understand the wealth of information contained in the Chart, the history of the United States is only 2 inches old over 8 feet of time.

Just ask yourself the following questions. Who came first, the Romans or the Vikings? Did the Babylonian Captivity of the Jews pre-date the Athenian Republic? Who brought the Greek gods to Egypt?

If you don't know (or even if you do), you'll find that The History Chart is a uniquely enriching educational experience for everyone. The History Chart has been on display in the Library of Congress.

There's no better way to see the panorama of human history, archaeology, theology and mythology than The History Chart. It even includes suggestions for further reading.

So fill out the coupon (or write on a separate piece of paper) and send it with your check or money order for $19.95 (plus $5.00 for shipping and handling) today. You'll soon be enjoying history as you never have before.

Please send me The History Chart. Enclosed is my check or money order for $24.95 (which includes $5.00 for shipping and handling). Add $15 for laminated Chart.

Name ____________________

Address ____________________

City/State/Zip ____________________

Mail to: International Timeline
2565 Chain Bridge Road
Vienna, Virginia 22180

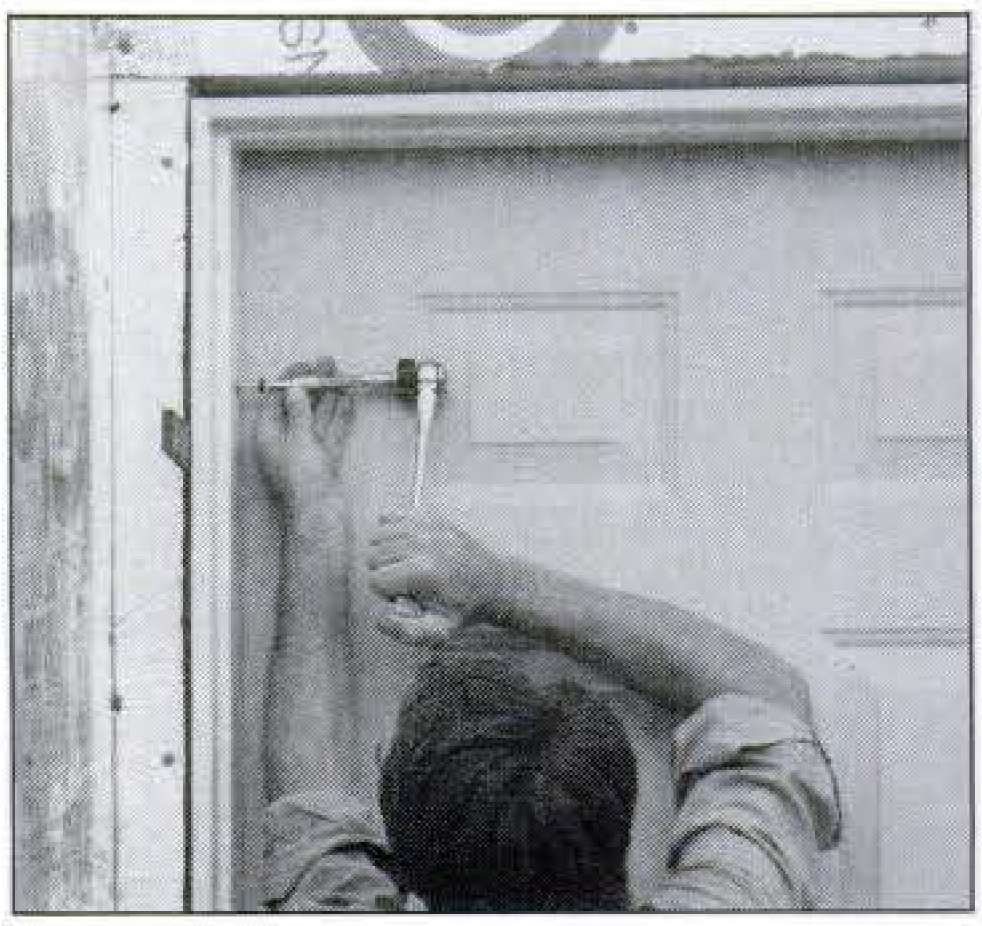
Virginia residents add 4% sales tax. Please allow 4-6 weeks for delivery. PS-1

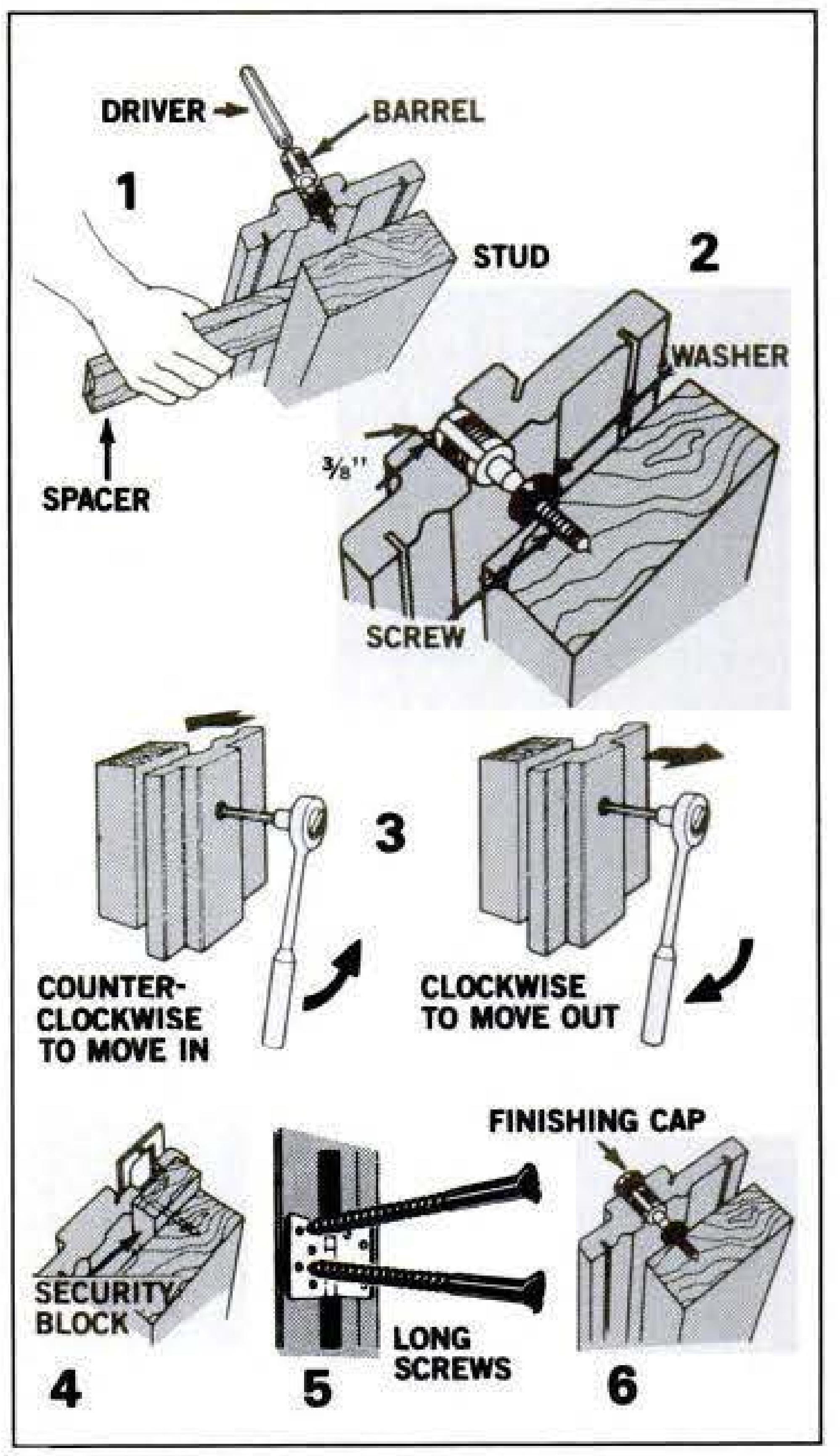
No-shim door framing

Easily adjustable screws replace clumsy shims and nails in the new Ever-Strait door-framing system developed by Pease Industries (Fairfield, Ohio). Ever-Strait doors come predrilled to accept six Jamb-Jacks—patented screw-in fasteners that move the frame in and out as required (photo). A special hexagonal drive tool that works with a 10-mm or $\frac{3}{8}$-inch socket wrench or a power drill is also provided in the kit.

To install Jamb-Jacks, locate the rubber centering washer on the screw two threads from the shoulder. Insert the driver's internal hex end in a Jamb-Jack barrel, and place the screw in a pre-drilled $\frac{9}{16}$-inch hole (1). If a power drill is used, hold a wooden spacer between the frame and the stud to prevent bowing. Drive the Jamb-Jack screw into the frame and stud until the barrel is $\frac{3}{8}$ inch inside the frame to provide space for the finishing caps (2). Remove the spacer. Repeat for the remaining five pre-drilled holes.

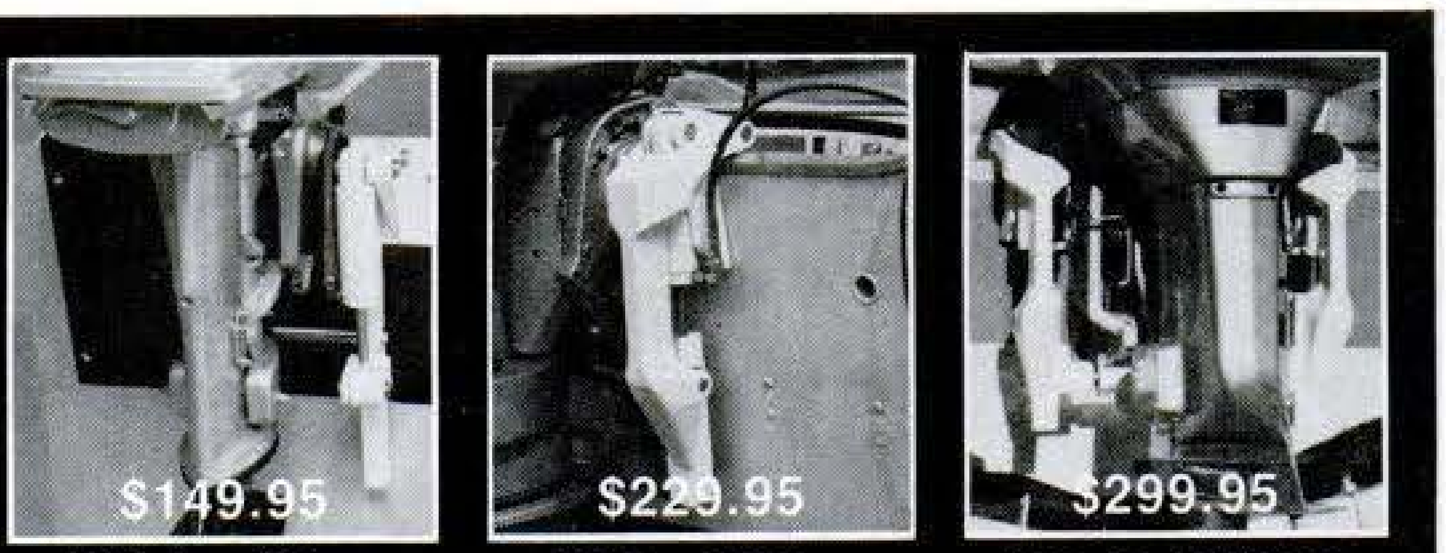
Open the door, and check the frame-to-door alignment inside and out. To adjust alignment, insert the hex driver's round end, and rotate the Jamb-Jack barrel in the frame with a wrench (3). Adjust the screws on each side one-quarter of a turn at a time. After the frame is square, insert a wood block between the jamb and the stud at the strike location for additional security (4). Drive two long screws through the strike plate and two more through the top hinge (5). Push the finishing caps into the holes (6).—*Steven Ashley*





80,000+ boaters have a Dole Kit on their outboard motor. Its unique design gives full control in the palm of your hand with the **patented non-electric double action hydraulic pump.**

SAVE UP TO 50% OVER OTHER MODELS!


$149.95 UP to 40hp TILT
$229.95 40 to 150hp TILT HD
$299.95 Up to 150hp TRIM-N-TILT

FOR FREE INFO., WRITE OR CALL **1-800-245-0357**
DOLE KITS Manufactured In KS Call Collect (316) 663-8361
BY ARROW MACHINE INC.
3310 E. 4th
P.O. Box 1987 PS
Hutchinson, KS 67504-1987

Name ____
Address ____
City ____
State ____ Zip ____

THE GREAT NORTHWEST HARDWARE COMPANY, LTD.

JAWS™
POWER • GRIP

SELF-ADJUSTING 10" or 14" RATCHETING WRENCH

1. Flip Head Back to Open
2. Press Jaws Together
3. Lock Tight-Automatically

- 360° ROTATING HEAD
- FITS ALL SIZES AND SHAPES – AMERICAN OR METRIC
- THE HARDER YOU PRESS – THE TIGHTER THE GRIP

ORDER		
J1010	10" Wrench, 1½" Bite	$19.99
J1014	14" Wrench, 2½" Bite	$29.99

FREE SHIPPING and HANDLING
THE GREAT NORTHWEST HARDWARE COMPANY, LTD.
P.O. BOX 6298 • ALOHA, OR 97006
1-800-835-2246, ext. 27 Outside Kansas
or **1-800-362-2421, ext. 27** In Kansas

HELP IN A HURRY
CAR EMERGENCY KIT

KIT CONTAINS
- 2-Cans Fix-a-Flat H.D. Tire Sealer with Hose Attachment.
- 1-12" × 12" Distress Flag.
- 1-Lifetime Flashlight with "stand-up" base.
- 1-Red Electronic Flasher (safer than flares).
- 1-Roll Heavy-Duty Radiator Hose Repair Tape.
- 2-Screwdrivers (Phillips & Flat).
- 1-Pair Slip Joint Pliers.
- 1-10" Ice Breaker Scraper.

All packed in a Waterproof case which fits compactly into trunk.

ONLY **$19.95** INCLUDES SHIPPING AND HANDLING

ORDER TODAY, GET 2 BONUS ITEMS FREE!

☐ Enclosed is my Check or Money Order.
Charge My: MasterCard ☐ VISA ☐ PA Residents add 6% tax.
Number ____ Expiration Date ____
Signature ____
(Credit card orders without signature cannot be processed)
PHONE ORDERS 1-800-345-4387
SEND TO:
PRESTIGE PRODUCTS P.O. Box 638, RICHBORO, PA 18954

Boom year for pickups

[Continued from page 69]

on truck option lists. Chevrolet, Ford, AMC, Toyota, Nissan, and Mitsubishi/Dodge pickups have four-speed automatics.

One of the newest four-speed units is built cooperatively by Aisin-Seki of Japan and Warner Gear, a U.S. company. This new transmission is electronically controlled and offers power and economy shift modes, an overdrive fourth gear, and a lockup torque converter. Variations of this unit are installed in the AMC Comanche and in Toyota and Mitsubishi pickups.

Four-wheel traction

Slow to a stop. Step out of the cab and into whatever you're stuck in. Walk up to the front axles and throw the axle-locking switches on the front hubs. Get back in the cab and haul back the reluctant four-wheel-drive lever. And finally, shift into gear and drive out of the sticky stuff. That's what engaging four-wheel drive used to be like. Today, with systems like Ford's optional Touch Drive, just press a button at any speed up to 50 mph, and you're four-wheeling.

Although it doesn't have push-button engagement, one of the best four-wheel-drive transfer cases is offered in the AMC Comanche. Called Selec-Trac, it's a system that provides a constant torque split between the front and rear axles using a planetary differential. Why is that important? The tires on a four-wheeled vehicle all travel the same distance when the vehicle moves in a straight line. But in a corner or during a turn, each wheel travels a different arc (distance). Without the differential, the mechanically linked wheels would all travel the same speed (and distance), and the drive line would bind or crab. On loose soil or slippery surfaces, this differential action is less important. It means, however, that transfer cases without a differential must be switched on and off—depending upon conditions. Selec-Trac can be left engaged—and ready—all the time.

Anti-lock braking

Not all effort in engineering has been concentrated on making pickups go better; much development has also been directed at making them stop better.

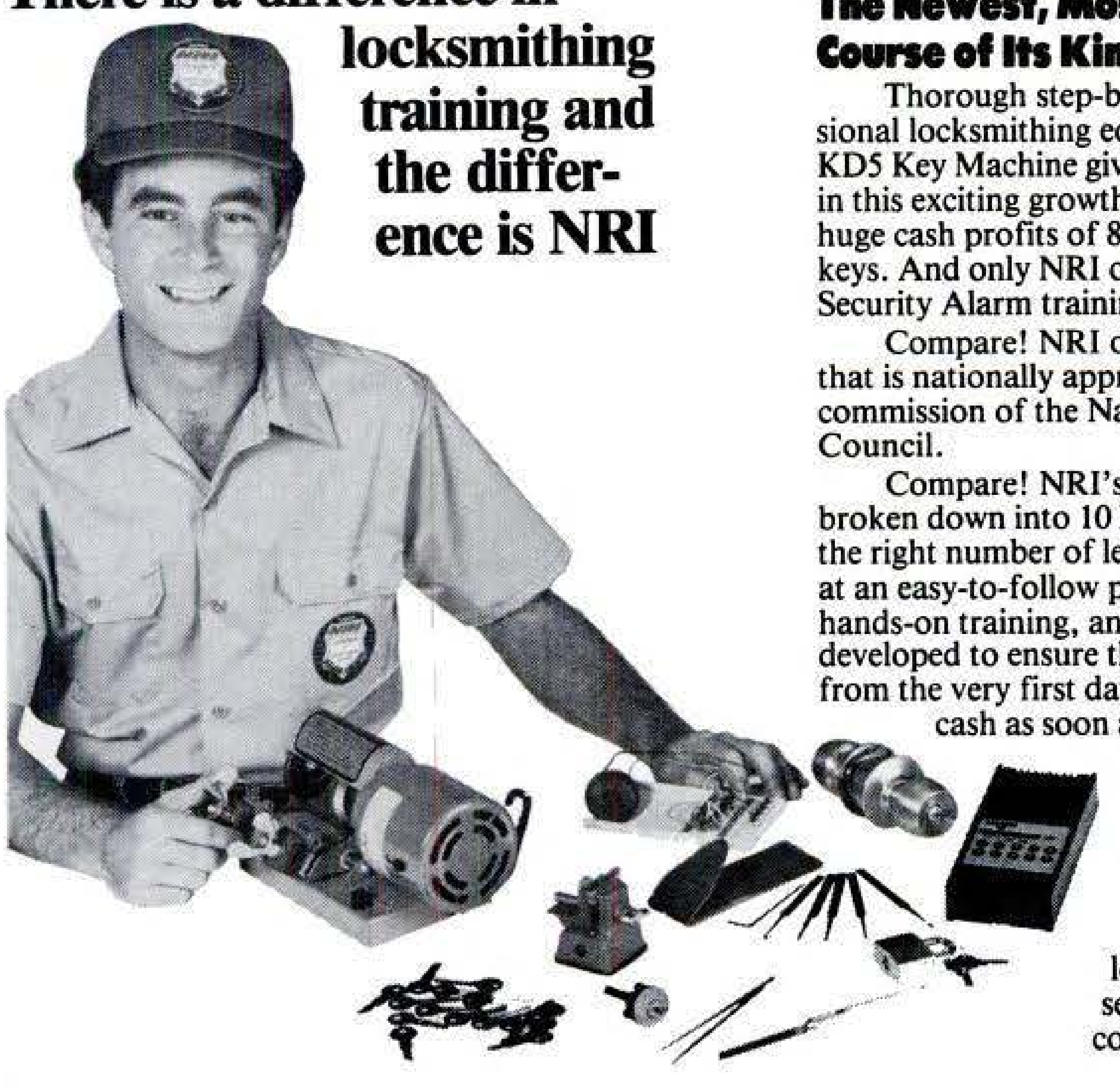
A big problem with pickups in the past has been their brakes: Design brakes so the truck stops properly with a full load, and you've got too much muscle at the rear when its unloaded. Result: The back wheels can lock. The rear-end swings around, and you lose control.

Now there's a solution. I had an opportunity to test it recently at Ford's Dearborn, Mich., test track. The weather was perfect—it was raining buckets. This is exactly the type of slippery condition that causes light trucks to spin during a panic stop. With water-soaked socks, I stepped into a pickup equipped with Kelsey-Hayes Co.'s new Electronic Brake Control rear anti-lock system and blasted into a brake lane at 60 mph. But even with both feet on the pedal, the truck stopped in the center of the lane with just a trace of sideways slip.

"The big advantage of a rear-wheel anti-lock system is that it keeps the rear wheels of the truck rotating during the stop," explained Ford's Rivard. "As long as the rear tires continue to roll, lateral friction is maintained, which keeps the vehicle tracking and helps the driver maintain control."

Eric Devore, project engineer for the rear anti-lock brake system at Kelsey-Hayes, explained how the system works: During a stop, a signal is sent

Continued



START YOUR OWN PROFITABLE CASH BUSINESS EVEN WHILE LEARNING!

BE YOUR OWN BOSS...BE A LOCKSMITH

There is a difference in locksmithing training and the difference is NRI

Only NRI gives you such complete training, so much real bench experience, and the confidence and all the tools you will need to earn cash money fast.

A well-trained locksmith earns money in many different ways—installing locks in apartments, homes, businesses, and automobiles, fixing broken locks, cutting new keys, and more. And this huge market is just begging for new qualified locksmiths. Today there is only one locksmith for every 18,000 people!

The Newest, Most Advanced Course of Its Kind

Thorough step-by-step lessons and professional locksmithing equipment such as the Taylor KD5 Key Machine give you hands-on experience in this exciting growth field. You'll start earning huge cash profits of 800% to 900% duplicating keys. And only NRI offers you an Electronic Security Alarm training system.

Compare! NRI offers the only course that is nationally approved by the accrediting commission of the National Home Study Council.

Compare! NRI's course training has been broken down into 10 learning modules, each with the right number of lessons to keep your training at an easy-to-follow pace. All the lessons, hands-on training, and experiments have been developed to ensure that you begin practicing from the very first day...and can begin making cash as soon as you like. All the money-making secrets of a locksmithing trade will become yours with your NRI training.

Plus, only NRI gives you training in both locksmithing and electronics security systems in one complete course.

Start Your Own Business, Full or Part-Time, Even From Your Home

Add to your income with part-time work with established locksmiths...start your own part-time or retirement business in your own home...make locksmithing and security a full-time career as a skilled technician in your own growing business. There is opportunity everywhere!

NRI's free 4-color booklet will show you how quickly you can train to be your own boss in a profitable locksmithing business and gain the respect you deserve as a trained technician like other professionals in your community

SEND FOR FULL INFORMATION BOOKLET! NO OBLIGATION, NO SALESMAN WILL CALL!

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue
Washington, DC 20016
We'll give you tomorrow.

For Career courses approved under GI bill
☐ check for details.

☑ CHECK ONE FREE CATALOG ONLY

☐ **Locksmithing & Electronic Security**
☐ Data Communications
☐ Robotics & Industrial Controls
☐ Color TV, Audio, and Video System Servicing
☐ Electronics Design Technology
☐ Digital Electronics
☐ Communications Electronics
☐ Industrial Electronics
☐ Basic Electronics
☐ Telephone Servicing
☐ Small Engine Servicing
☐ Appliance Servicing
☐ Automotive Servicing
☐ Air Conditioning, Heating, Refrigeration, & Solar Technology
☐ Building Construction
☐ Computer Electronics with Microcomputers

Name (Please Print) Age
Street
City
State/Zip 1702-106
Accredited by the National Home Study Council

From Europe . . . The Ultimate in

HISTORIC SHIP MODEL KITS.

Plank-on-frame Construction

World famous kits from Europe. Large, magnificent replicas (many over 4 feet long!) with beautiful walnut and mahogany planking, fittings and details exquisitely cast in bronze, brass and rare hardwoods. Large scale plans, step-by-step instructions, all materials included. VHS Video tape cassette on how to build also available.

Send for 64-pg. full-color catalog only $1.00

MAIL THIS COUPON TODAY!

MODEL EXPO, INC. Dept. PS-106S
23 Just Road, Fairfield, N.J. 07007

Please send me a full color ship model catalog. $1.00 is enclosed.

Name ______
Address ______
City ______
State ______ Zip ______

GIANT HEAVY DUTY INFLATABLE BOATS

2 MAN $38

3 MAN $50

4 MAN $65

Call Free
Before Midnight For The Next 30 Days

As part of an advertising test, *Dunlap Boat Mfg.* will send any of the above size boats to anyone who reads and responds to this test before the next 30 days. Each Boat Lot No. (Z-26 PVC) is constructed of tough high density fabric (resistant to abrasions, sunlight, salt & oil), electronically welded embossed seams, nylon safety line grommeted all around, heavy duty oar locks, 3 separate air chambers for extra safety (4 air chambers in 4-man), self-locking safety valves, bow lifting & towing handle and are recommended for marine, ocean and fresh water recreation, camping, fishing or a family fun boat. Each boat will be accompanied with a **LIFETIME** guarantee that it must perform 100% or it will be replaced free. Add $7 handling & crating for each boat requested. *Dunlap Boat Mfg.* pays all shipping. If your order is received within the next ten days you will receive FREE a combined hand/foot inflator/deflator bellows style pump for each boat requested. Should you wish to return your boat you may do so for a refund. Any letter postmarked after 30 days will be returned. LIMIT three (3) boats per address, no exceptions. Send appropriate sum together with your name and address to: Boat Dept. #177-C, *Dunlap Boat Mfg.*, 2940 W. Pico Blvd., Los Angeles, CA 90006. Or for fastest service from any part of the country call 1-800-824-9988 for Boat Dept. #177-C (Calif. residents call collect 213-735-9363), before midnight seven days a week. Have credit card ready.

COMB

Authorized Liquidator

PROTECTIVE COVERS

CLOSEOUT PRICES!

These tough, light-weight ALL SEASON covers are factory overstock. They wrap around your vehicle to guard against dirt, dust, rain, snow, tree sap, frost, etc.

- Covers are rugged nylon taffeta.
- Acrylic coating resists moisture, rot.
- Stretch ends for snug, pull-tight fit.

Measurements: Bumper to bumper. Allow 10"-15" extra length for one-piece wrapunder bumpers, wagon models or cars pre-1959.

SMALL 150"-165"	**Mfr. List: $69.95** **Liquidation Price . . .** **Item H-1509-4514-006 S/H: $3.50**	**$25**
MEDIUM 166"-180"	**Mfr. List: $79.95** **Liquidation Price . . .** **Item H-1509-4514-014 S/H: $3.50**	**$27**
LARGE 181"-192"	**Mfr. List: $89.95** **Liquidation Price . . .** **Item H-1509-4514-022 S/H: $3.50**	**$30**
X-LARGE 193"-210"	**Mfr. List: $99.95** **Liquidation Price . . .** **Item H-1509-4514-055 S/H: $3.50**	**$33**
JUMBO 211"-235"	**Mfr. List: $109.95** **Liquidation Price . . .** **Item H-1509-4514-030 S/H: $3.50**	**$36**
MOTOR-CYCLE	**Mfr. List: $39.95** **Liquidation Price . . .** **Item H-1509-4514-048 S/H: $3.50**	**$15**

Credit card customers can order by phone, 24 hours a day, 7 days a week. VISA MasterCard AMERICAN EXPRESS

Toll-Free: 1-800-328-0609

Sales outside the 48 contiguous states are subject to special conditions. Please call or write to inquire.

C.O.M.B. Direct Marketing Corp. **Item H-1509**
1405 Xenium Lane No./Minneapolis, MN 55441-4494

Send **Car Cover(s)** shown below. Add $3.50 each for ship, handling. (Minnesota residents add 6% sales tax. Sorry, no C.O.D. orders.)

Send___**SMALL** @ $25 ea. Item H-1509-4514-006
Send___**MEDIUM** @ $27 ea. Item H-1509-4514-014
Send___**LARGE** @ $30 ea. Item H-1509-4514-022
Send___**X-LARGE** @ $33 ea. Item H-1509-4514-055
Send___**JUMBO** @ $36 ea. Item H-1509-4514-030
Send___**MOTORCYCLE** @ $15 ea. Item H-1509-4514-048

☐ My check or money order is enclosed. (No delays in processing orders paid by check).

Charge: ☐ VISA® ☐ MasterCard® ☐ American Express®
Acct. No. ______ Exp.___/___
PLEASE PRINT CLEARLY
Name ______
Address ______
City ______
State ______ ZIP ______
Phone ( )
Sign Here ______

COMB Direct Marketing Corp.
Authorized Liquidator
1405 Xenium Lane North
Minneapolis, Minnesota 55441-4494

Boom year for pickups

Continued

from a speed sensor located in the rear-axle housing. The sensor picks up rear-wheel speed (deceleration) off a toothed wheel on the axle's ring gear. This information is sent to the control unit, or brain. There it's compared with a stopping calculation in the microprocessor's memory. If rear-brake-system torque exceeds the tire's ability to grip the road, the wheel slips —decelerating too rapidly. A signal is then sent from the module to the electrohydraulic control valve, and brake pressure is bled just enough to keep the wheels turning.

According to experts at Ford in Dearborn and Kelsey-Hayes in Romulus, rear-wheel electronic braking control is far simpler, more rugged, and far less expensive than the four-wheel anti-lock systems now used on a few expensive sedans.

Ford will introduce the system as standard equipment on three of its 1987 truck lines, including the new F-series. Other light-truck makers are expected to follow, although Chevrolet/GMC and Chrysler refuse to talk officially about their plans.

A reliable though slightly less capable braking device than the Kelsey-Hayes unit is the load-sensing proportioning valve. It's used on the AMC Comanche, the Dodge Dakota, all Toyota trucks, and several other pickups. Its job is to detect the amount of bed loading through a mechanical linkage attached to either the bed or the suspension. A simple valve within the device then increases the amount of hydraulic pressure distributed to the rear brakes as the bed is loaded.

"It gives us about eighty percent of what an anti-lock system would," says Chrysler's Glen House, program management chief on the Dakota.

I believe it works after brake testing the Comanche for our February '86 test. Comanche had consistently short stops that were much more stable than its competitors without the valve. They were, however, not as well controlled as anti-lock stops.

Civilization comes to pickups

To make trucks more appealing to passenger-car buyers, truck makers are making cabs roomier and quieter, increasing optional features, and smoothing the ride.

Driving a pickup no longer means having to rough it. Sound systems, power options, and even fancy paints dress up the smallest and biggest pickups for Saturday nights on the town. There are even cab extensions that provide extra seating space. Of course, as with cars, options don't come cheap.

This attention to interior detail

would be useless if pickups still rode and handled like trucks. But they don't. Engineers are installing gas shocks for smoother, more consistent damping; independent front suspensions with computer-selected springs; and variable-rate (two-stage) rear leaf springs.

"The main contributor to better ride for us in our '87 line is gas shocks," says Ford's Rivard. "The gas shock absorber provides a wider range of compromise. It can give you big-bump control and still handle motion control for small bumps. The whole range is improved, so it's a more carlike ride."

One of the best handling and riding pickups of the new crop of domestics is the Dodge Dakota. Its independent front suspension incorporates computer-selected coil springs with rubber-isolated upper and lower control arms.

Chrysler engineers installed two-stage leaf springs to make the rear of the Dakota ride smoothly. The first stage handles the unloaded truck. The second stage, with a higher spring rate, becomes involved when the bed is loaded.

Among the import compacts I tested, the 1987 Mitsubishi pickup is the best riding and handling. "There haven't been any quantum leaps in ride engineering, but there have been important refinements," explained Ron Kusumi, manager of product development. We'd just driven up some rocky trails high above the coast of Hawaii's Kauai Island. "They're little things we tweak, like low-friction sliders between the leaves and different-rate bushings in the spring ends. You still get the load capacity, but you get a better ride."

Ride comfort isn't the only concern of new-truck buyers. Better sound and vibration attenuation have also become more important.

"Quieter vehicles ride better," said D. E. Dawkins, director of Chrysler's truck program management, as we climbed up the Mount Rushmore approach road in a new Dodge Dakota. "Of course, that's not technically true, but that's the customer's perception. So our attention to sound isolation in the Dakota makes the ride seem better than it already is."

Another area receiving sound-reduction attention has been the engine compartment. Engine noises are being damped by more rigid cast brackets for pulley-driven components, remote air cleaners, cast rocker covers, and, of course, traditional sound-attenuating blankets. In addition, engine vibration is being better isolated through the use of new rubber compounds and shear-type mounting systems.

Coping with corrosion

Nothing wipes the grin off a truck owners face faster than the first signs of that brown scourge—rust. Many times a pickup's engine and drive line far outlive the sheet metal. Today, manufacturers are extending the sheet metal's life with better anti-corrosion materials and techniques.

The freshest example of this rust-resistance technology is the Dodge Dakota. It's built almost exclusively of galvanized or galvannealed steel. Even the front suspension's upper and lower control arms are galvanized. Further, the frame is wax-dipped. And even the exhaust system is made of a corrosion-resistant steel alloy and is included in Chrysler's 5-year/50,000-mile corrosion warranty.

Finally, reflecting the increased interest in trucks by passenger-car buyers, sophisticated clear-coat paints are now being used on pickups.

What's available?

The hotly contested bottom of the pickup market is occupied by both import and domestic compacts made by Toyota, Nissan, Mazda, Isuzu, Mitsubishi/Dodge, Ford, and Chevrolet. Payloads for the compact field range from 1,000 to 2,500 pounds, and wheelbases run from 103 to 125 inches.

The mid-size pickups are the newest segment. These handle loads from 1,250 to 2,550 pounds. Their wheelbases stretch from 111.3 to 129.5 inches, and bed sizes are between 6.5 and 8 feet. The representatives in this class are the AMC Comanche and the Dodge Dakota introduced this month.

The top of the market is dominated by two truck leaders—Ford and Chevrolet/GMC. Ford is introducing a completely revamped F-series pickup this month and will spend $4 million to launch it. Chevy will bring a new full-size to market in 1987. Trailing far behind the leaders with 160,574 sales last year is the Dodge D-series pickup. (Dodge's new full-size, code-named Louisville Slugger, isn't due out till 1991.) These traditional load luggers can haul payloads of up to 8,700 pounds and sport engines as large as 7.4 liters. Wheelbases can be as short as 115 inches and as long as 168.4.

The boom has started: The days of design hibernation are over for pickups. More size variations, supercharged and turbocharged engines, increased use of unitbody-construction techniques, electronic suspensions, and front-wheel drive are just a few of the things engineers hint are just over the horizon.

FACTORY NEW! FACTORY PERFECT!
Total System 6K RAM

SEIKO LIQUIDATION

Get the entire SEIKO system NOW at our special liquidation price!

Quantities of this futuristic product are limited

SEIKO'S RETAIL PRICE ~~$285.00~~

DAMARK INTERNATIONAL PRICE:

$98

(PLUS INSURED SHIPPING AND HANDLING: $6.00)

This SEIKO watch plugs right into this compact **desk-top personal computer.** Now, you can enter all kinds of important data into your SEIKO watch, and have that information with you . . . on your wrist . . . everywhere you go!

For the busy executive . . .
You can have appointment schedules, travel intinerary, critical phone numbers, deductible expenses, even key phrases in your sales pitch . . . right on your wrist.

For the student . . .
Imagine having all your hard-to-remember formulas, equations, dates and places stored in your watch . . . and the ability to recall any of them when you need it the most!

The watch: 2K RAM memory. Day/Date/Time. Stopwatch and Alarm function.

The Computer: 4K RAM, Typewriter keyboard, built-in printer. Complete. step-by-step instructions. Total system covered by SEIKO's full factory warranty.

For fastest service, call TOLL-FREE
1-800-328-5727
or send check money order or credit card information to:

DEPT. B-113
DAMARK INTERNATIONAL, INC.
7714 Brooklyn Boulevard, Minneapolis, MN 55443
Corporate Offices • (612) 560-5415

NAME ____
ADDRESS ____
CITY, STATE, ZIP ____
PHONE ____
☐ Check/M.O. ☐ VISA ☐ MasterCard
CARD NO. ____
EXPIRATION DATE ____
SIGNATURE ____

Monster chips

Linking microelectronic circuits together on silicon discs—rather than slicing them into tiny chips—is an extraordinarily complex job that is taxing the best laboratories. But ingenious technological approaches are solving the problems step by step.

By T. A. HEPPENHEIMER

TROY, MICH.

"Silicon Valley is in a rut," says Robert Johnson, whose electronics firm, Mosaic Systems, is in this Detroit suburb. "See this chip package?" He hands me an unsealed housing for a microchip. Normally, a small silicon chip occupies the empty space in such a housing. "That space is called the cavity," says Johnson. "In Silicon Valley, everyone is just concerned with what can fit into that cavity. We're trying to do things differently."

He then gives me a plastic lid holding a thin silicon disc four inches across. The silver-gray disc is crisscrossed with a grid of lines. Mounted to the silicon are a number of chips —the type that normally occupies the small black housing I first held. "With our technology, we can mount all types of chips," Johnson explains. "All of them, interconnected on silicon, would provide a system that resembles a single chip several inches in diameter.

"We'll show you the kind of thing we think we could put a Cray 2 in," he says. The Cray 2 is the world's most advanced supercomputer, capable of up to two billion calculations per second. In a small laboratory, Johnson points to a thick-walled plastic cylinder a foot high and eight inches across. "That's what we plan to mount wafers in. We'll immersion-cool them in Freon [refrigerant] at minus twenty degrees Celsius. We can stack the wafers eight to the inch. That would provide Cray power in a desk-size system."

His work represents the next major goal of the microelectronics industry. The last big development, very large-scale integration (VLSI), put complete computers on single chips and brought about the microcomputer revolution. Such chips, the size of a fingernail, are fabricated in large numbers on thin silicon wafers—some four inches or more in diameter. Sliced from the wafers, the chips are tested: Defective microcircuits are thrown away, and good circuits are packaged.

Now the big push is on to develop what engineers call wafer-scale integration: making saucer-sized silicon wafers containing the equivalent of dozens or scores of VLSI chips connected together. Such large-scale chips, containing millions of transistors, diodes, and other components, would have important advantages.

First, although today's microcircuits are cheap—a microprocessor chip may cost less than $10—costs increase rapidly when hundreds of chips must be mounted and interconnected. Wafer-size chips would reduce these costly interconnections. What's more, the small size of wafers would mean faster computers—in supercomputers, things happen in billionths of a second. During such short intervals, signals moving at the speed of light travel a foot or so. So shrinking signal paths from feet between circuit boards to inches on a wafer will greatly aid supercomputer design.

But as you might guess, there are problems. When chips are made significantly larger than those in use today, the number of defective chips —and their costs—rise astronomically. Nevertheless, a number of researchers are working feverishly to push ahead into this high-risk—but potentially high-gain—field. And while some have failed catastrophically, others are tackling the problems of wafer-scale integration in fascinating and ingenious ways, and they're making progress toward developing wafers with some of the needed characteristics:

- Johnson's Mosaic Systems is developing the dense interconnection of existing chips based on a strange glasslike semiconductor he calls an "antifuse."
- Bruce McWilliams of Lawrence Livermore National Laboratory's supersecret O Group, involved in Star Wars research, is pursuing what he calls laser pantography—using lasers to write finely detailed patterns directly onto silicon.
- Clive Sinclair's former company in England is already producing a version of wafer-scale memory that figures out how to repair its own flaws. It finds the good areas and routes signals around flawed regions.
- Carver Mead at the California Institute of Technology, in Pasadena, is exploring radically new approaches to computer design based on the system used to link networks of neurons in the brain.

Chip photomasks

Tour a semiconductor plant producing conventional VLSI chips today, and you'll quickly realize the staggering problems inherent in wafer-scale integration:

In rooms aglow with computer-graphics screens, design engineers check a final chip pattern—a maze of intersecting lines and junctions—readied in a computer. This pattern, eventually transformed into thousands of transistors and wires only microns (millionths of a meter) in size, is converted—by various techniques—into a finely detailed photographic negative called a photomask. So tiny are these pattern features that a speck of dust can ruin a chip.

Next, photomask patterns are reproduced thousands of times, day after day, on a stream of silicon wafers. Dozens or hundreds of patterns, depending on chip size, cover each wafer. To imprint the pattern, workers deposit a thin film of a light-sensitive chemical solution called photoresist on wafers. Ultraviolet light beamed through a mask exposes the photoresist; an acid bath rinses away exposed photoresist. Then, steps involving other masks deposit layers of insulating material and conductors, or diffuse atoms of impurities into the silicon to form positive or negative areas.

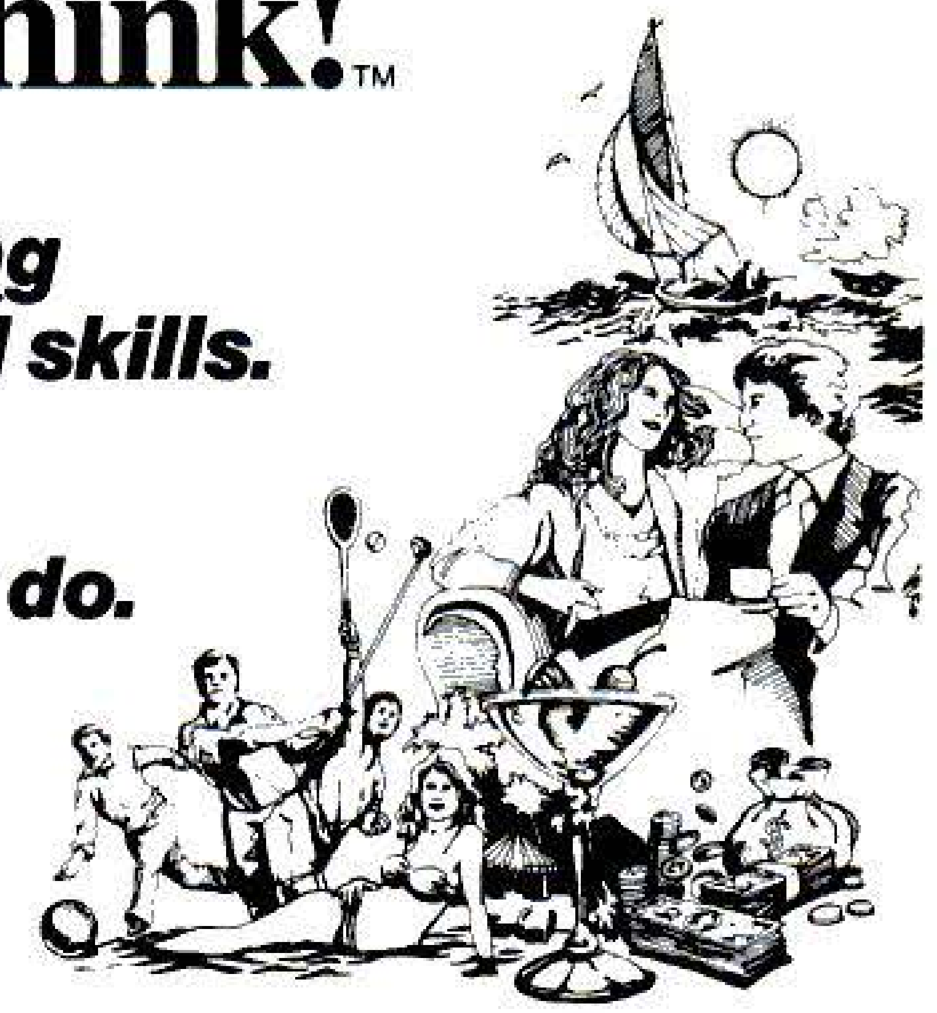
So what happens when this extremely delicate VLSI fabrication technique is used to produce not individual chips but one giant interconnected circuit that may be composed of millions of individual circuits on a single wafer? Work done by Gene Amdahl, a leading computer designer,

Continued

INSTANT MEMORY®

You are greater than you think!™

- A quantum leap in unleashing hidden abilities, talents, and skills.
- Guaranteed to improve your performance in everything you do.
- Used by over 200,000 for insight, creativity, knowledge, and profit.



Success depends on it . . .

INSTANT MEMORY is the fastest, surest, most enjoyable method ever devised to acquire a perfect memory *without even trying.*

No memorization, no word association.

It helps you solve problems *fast*. Reduces stress, fatigue. And even improves your tennis game!

Release your photographic memory. Nothing is forgotten! Learn "how" you remember, "why" you forget. Discover a natural ability of your mind to instantly recall everything you see, read, hear.

You can have a photographic memory.

With **INSTANT MEMORY**, anyone can remember anything . . . *without even trying!* It unshackles your perfect memory from self-imposed exile instantly. This new way to remember is so simple, quick and usable, everyone can use it immediately.

Age is no barrier.

Why? Because the results are automatic. It is the easiest way to remember names, faces, dates, speeches, formulas, music, phone numbers, *and even entire books.*

Pass exams easily!

If you are in school, with **INSTANT MEMORY** you can *permanently* remember all you will ever study. Now you can *easily* pass every exam with less study, no worry and no "test trauma." Increases your vocabulary, improves spelling, masters foreign languages.

Here's how it works . . .

Science has proven the accumulated experience of a lifetime is preserved perfectly in your mind. **INSTANT MEMORY** simply releases it! Without word associations. Just the natural powers of your mind. It's a spectacular way to put a lifetime of learning at your fingertips. And it's your birthright!

About the INSTITUTE

For over 22 years, the Institute of Advanced Thinking has earned a reputation of proven reliability and integrity. It has gained international acclaim as the world's first and only instruction in Natural Memory.™ The Institute is a member of the American Association for Adult and Continuing Education, Direct Marketing Club of Southern California, and Pacific Palisades Chamber of Commerce.

Play any sport better!

INSTANT MEMORY means your game just got better *without practice*. Why? *Because the "perfect game" exists inside you right now!* Simply learn how to "unleash" it.

Learn any skill.

INSTANT MEMORY means learning new skills at a speed you didn't think possible. Because it's a natural state of mind. It comes built-in. So you don't have to work for it. *No repetition, no relearning!*

Win at cards, give speeches, overcome stage fright.

This is far more than just a "memory" course . . . *it is a new way of living.* **INSTANT MEMORY** enables you to play any musical instrument, find lost articles, awaken the exact moment you desire, tell stories and jokes without nervousness, improve your typing, think faster, and much more!

There's no end to the things you can do with **INSTANT MEMORY**.

MINDSTORMING® – your key to creativity.

With this amazing technique originated by the **INSTITUTE**, you can *instantly* liberate your inner creative abilities and *natural* intuitive powers. It floods your mind with a fortune of money-making ideas. There is no limit to what you can discover, invent or produce!

Instant speed reading.

The first time you read something should be your last! Now you can *instantly* remember *all* you read. Because you will read a page like a photograph! With **INSTANT MEMORY**, there is *no* limit to the words you can read per minute.

© INSTITUTE OF ADVANCED THINKING 1981

SUCCESS. Supersuccess comes when you transform the way you look at yourself! The discovery of a more powerful self guarantees a richer, more rewarding lifestyle.

MINDPOWER. Unlock the "sleeping" potential of millions of years of evolution. You can penetrate deeper levels of mind.

WINNING. The fastest way to the top is by developing your thinking skills. Lose the "loser mindset." Uncover *uncommon* intelligence.

ATTRACTIVENESS. You'll be admired for your wit, wisdom, and charm. INSTANT MEMORY guarantees applause and respect.

TRANSFORMATION. Become what you always knew you could. There are no barriers.

BODY/MIND. Learn how your mind can easily direct your body. Automatically, effortlessly.

MIND BEYOND MATTER. Controversial thesis that mind transcends brain. Mind, freed of sensory confinement, can be a source of extraordinary evolutionary development.

PARANORMAL. Nature "wired" you with capacities you haven't used. This redefines ESP as a natural potentiality.

SELF-KNOWLEDGE. What happens when you know yourself better? You look better, feel better, act better. And other people treat you better!

FULL MONEYBACK GUARANTEE

If you are not satisfied, simply return your book within 30 days for a complete refund. Absolutely no risk!

Institute of Advanced Thinking
845 Via de la Paz, Dept. PS 1086
Pacific Palisades, California 90272

Yes, please send me your unique **INSTANT MEMORY** book for only $10 complete by First Class Mail at no extra cost.

Name ______________________________

Address ______________________________

City ______________ State ________ Zip ________

Or charge my ☐ VISA ☐ MasterCard

Card No. ______________________ Exp. Date ________

Copyrighted material

shows just how tough such a task can be. Several years ago he formed a new firm, Trilogy Systems, in Cupertino, Calif., and raised $230 million to produce complete computer circuits on wafers ["Giant Microcircuits for Superfast Computers," PS, Jan. '84].

"We were going to build a very high-performance computer," Amdahl recalls. Trilogy estimated that existing chip-fabrication techniques would put about 200 faults, randomly distributed, on each wafer. To compensate for these defects, Trilogy decided to put three copies of each logic block on a wafer. Tests would locate bad circuits and shut them off, allowing wafers to work despite their faults.

Problems abound

Amdahl's computer design called for wafers with five million transistors each. To create this awesome complexity, Trilogy relied on a computer-aided design (CAD) system. Today, CAD is vital to developing new chips. "We had the world's most fantastic CAD system," Amdahl recalls. "But it was complicated, hard to debug. The complexity was too great for people to handle." The problem with their CAD delayed the project and drove up costs.

Then problems developed with the standard fabrication techniques. Trilogy's plan: lay down thin strands of insulator on the silicon-wafer base, then cover the strands with conducting paths of copper. The copper, however, would not adhere well to the insulator. The engineers thus planned to deposit another metal over the insulator before applying the copper. This new metal, deposited in thicknesses of a few angstroms (one-hundred-millionths of a centimeter), would prime the insulator, firmly bonding the copper.

For existing chips, nickel is a suitable metal for this task. So again Trilogy borrowed a familiar technology. But monster-size chips—Amdahl's wafers—produce different types of mechanical stress. Peering into their microscopes, Amdahl's engineers saw with alarm that these strains had cracked the brittle nickel, producing serious flaws in the overlying copper. So the hunt for a new metal primer began. Months later, titanium proved satisfactory. Then, using the faulty CAD system, Trilogy overhauled the wafer design to accommodate titanium—and lost additional months.

But the process proved educational. "Putting in the logic, going through the CAD system to generate masks, checking masks against specifications, producing wafers, and getting ready to test them," explains Amdahl, demonstrated the time requirements and complexity of wafer development.

The fabrication technique did provide wafers. But silicon discs averaged 1,000 faults, not 200. The goal of 200 faults for a production run demanded still more tedious, expensive redesign. That would take two more years and $150 million. "That was the source of our financial trouble," says Amdahl. In 1984 Trilogy abandoned its pursuit of wafer-integration computers.

Trilogy's failure highlighted the most difficult parts of the wafer-integration problem. Could researchers with less ambitious goals succeed? Mosaic Systems, part of a new high-technology boom in the Detroit area, is one firm trying a less formidable approach. The key to Robert Johnson's wafers at Mosaic is earlier work of Stanford Ovshinsky, a maverick inventor also based in Troy. During the 1960s, Ovshinsky challenged the pre-

Continued

Etching neural systems in silicon

Carver Mead of the California Institute of Technology, widely hailed as the co-inventor of VLSI, once calculated that a transistor's size could be as small as 0.25 micron. "I got to thinking about what that meant," he recalls. "It meant you could put a hundred million transistors on a chip. And, I said, I'm in the wrong business. No one has ever made a circuit with a hundred million of anything. That's a computer-science problem, and I wasn't a computer scientist. So I changed fields. It took me several years."

Hearing and seeing on a chip

Mead is now trying an entirely different approach: applying the organization principles of neurons in the brain to microelectronics to thus reduce circuit failures. He is building working models of cochleas (ear mechanisms that convert vibrations into nerve impulses) and retinas (part of the eye that converts light into nerve impulses). "The brain has this wonderful property: You can go through and shoot out every tenth neuron and never miss them," Mead says. "That's a property computers just don't have. It's the right way to do wafer-scale integration. You can't just use brute force with existing techniques, because they're fragile against errors. I want to build neural-like systems and do behavioral studies on them—knowing what the design is—to learn about the brain."

On a workbench in his lab, a small silicon chip simulates a simple neural network. It acts as a feedback loop (part of an output fed back to an input), keeping a varying voltage nearly constant. A liquid-crystal display blinks every few seconds, reading out the voltage. "There's gobs and gobs of feedback everywhere in neural systems," he says. "So we'd better figure it out." He picks up a microchip. "This is one of our cochleas; there's working silicon on it. It's not a very good cochlea right now. But it's a hell of a lot better than the first one any animal ever had. And we can evolve it from there.

"In neural systems, two things are violently different from any systems engineers have built. First, there are about as many wires running toward the sensors as are running back away from the sensors. This means it's as important to send the more-processed information back down to the next level, to guide its response, as to send the raw information on up.

"Second, many of them are a hundred percent analog. Real retinas don't turn digital, for instance, until they get to the optic nerve. Nature makes very good use of the gray scale. To use a TV camera as a front end for a vision system—that's insane," says Mead, referring to the gray-scale loss of video cameras. "You lose a lot of information, which you then have to try to reconstruct by artificial-intelligence techniques."

On the walls of his lab, circuit diagrams closely resemble the regular patterns of memory chips. These are examples of the new architectures he is studying, which mix in the processing along with the memory. "It gives you a hundred times more computing power if you do it that way," Mead says.

"I could show you our retinas; they handle various stages of processing. We can do about half of what the [human] retina does. It took us three years to get to our first retina. It's a hundred percent analog, with 100,000 analog circuits on it. I believe we'll have robots with big wafer-size eyes when we're done. They'll effectively mix the processors in with the receptors."

Analog rather than digital circuits; architectures that mix processing with memory; approaches drawn from neuroscience: All that is a far cry from Amdahl's work. "You know what Trilogy is like?" asks Mead. "You've heard it said that to a carpenter with a hammer, the whole world looks like a nail. Well, Amdahl is this big tall carpenter who's had nothing but nails all his life. And someone comes along with a bolt and nut. It doesn't pound in too well, so he goes and gets a bigger hammer. He doesn't say, 'Oh, if I turn it, it's easy.'

Silicon survivors

"Wafer-scale integration is one reason why the kind of computing that goes on in the brain is important. We're saying, What is the basic computational metaphor that's known to be resistant to errors? We have glimmers as to how the brain works, and we know how it has been tested in evolution. For instance, why does an animal's cochlea have this funny delay line to separate out the sounds? The answer is, The animals that didn't do it that way got eaten by the ones that did."

Perhaps, in time, links will develop between the computer and neural sciences. In wafer-scale integration, then, the term "electronic brain" may become more than just a figure of speech. And in Silicon Valley, the companies that don't do it Mead's way may be eaten by the ones that do. Beyond today's half measures that reach toward wafer-scale integration with only limited promise, the true promise of the technology may await our ability to recreate in silicon the processes of the brain itself.—T. A. H.

What's New at
AMERICAN DESIGN COMPONENTS?

"The Source" of the electro-mechanical components for the hobbyist.

We warehouse 60,000 items at American Design Components — expensive, often hard-to-find components for sale at a fraction of their original cost!

You'll find every part you need — either brand new, or removed from equipment (RFE) in excellent condition. But quantities are limited. Order from this ad, or visit our retail showroom and find exactly what you need from the thousands of items on display.

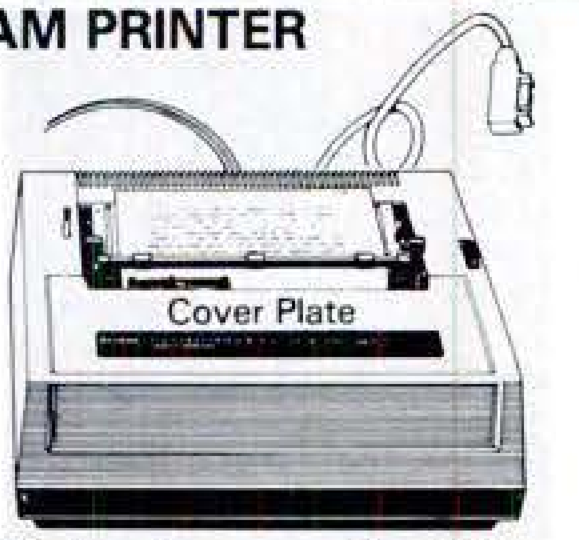
Open Mon. - Sat., 9-5

THERE'S NO RISK.
With our full 90-day warranty, any purchase can be returned for any reason for full credit or refund.

ADAM COMPUTER KIT!
(Less printer & w/o cabinet)

Build it yourself from subassemblies. No wiring necessary (just plugs together). Hook-up diagram included. Includes: Keyboard, 1 cassette digital data drive, 2 game controllers, power supply, all memory boards, and one cassette. Is capable of running CP/M, has built-in word processor.
Item **#7410** **$99.00** (complete)

ADAM PRINTER

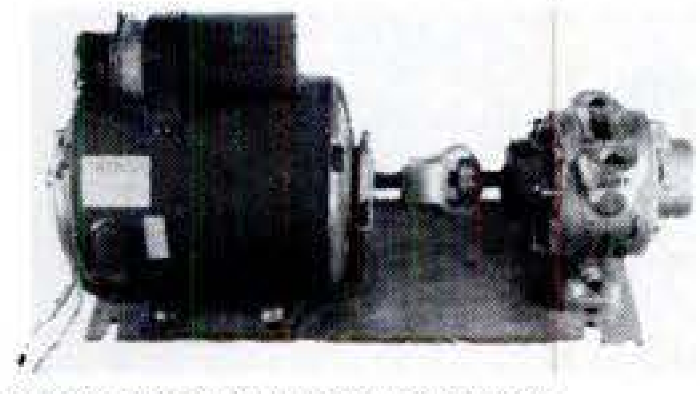


Complete, less top cover plate. Friction feed. Takes standard paper 8½" x 11". (Customer returns; tested — operational.)
Item **#8839** **$69.50**

ADAM ACCESSORIES

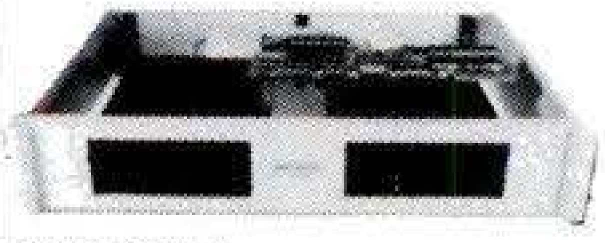
Data Drive	**#6641**	**$9.95**
ASCII Keyboard	**#6643**	**$19.95**
Asst. Cassettes	**#7786**	**$19.95**
D.D. Power Supply	**#6642**	**$14.95**

VACUUM PUMP & MOTOR

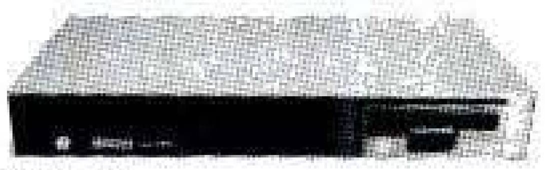


Usable for vacuum or pressure application. 4 CFM/15 PSI max. 15" cont., 28" intermittent. Pump is directly coupled to a GE 1/3 HP, 1625 RPM, 115 VAC, 50/60 Hz., single phase 3.8A motor. Thermally protected. Mounted on a metal base. Dim: 5¾"W x 14⅜"L.
Mfr-Gast 0040-V119 (oil-less) & GE
Item **#5327** **$39.95** RFE

DUAL 3¼" DISK DRIVE EXPANSION MODULES



IBM PC Jr.
Side-by-side mounting (PC Jr. mounts on top). With floppy disk drive controller board. Contains: 2 Tabor TC-500 3¼" disk drives. Total cap. 500K bytes unformatted*
Item **#8825** **$199.00** NEW

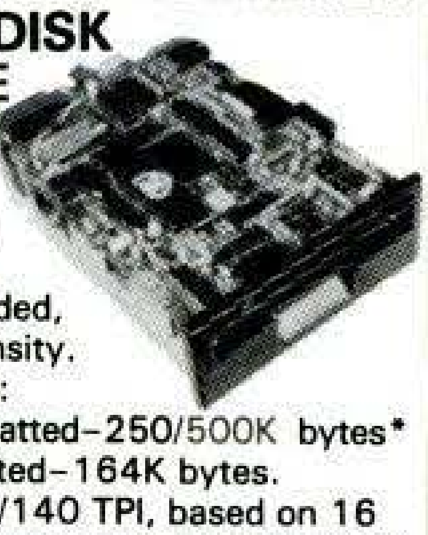


APPLE
Side-by-side mounting with disk storage space in front. Floppy disk controller board capable of handling four disk drives. Contains: 2 Tabor TC-500 3¼" disk drives. Total cap. 500K bytes unformatted*
Item **#8826** **$199.00** NEW

IBM PC/XT
Stacked mounting, replaces old-fashioned 5¼" disk drives. Contains: 2 Tabor TC-500 3¼" disk drives. Total cap. 500K bytes unformatted.* Plugs right into your controller.
Item **#8827** **$169.00** NEW

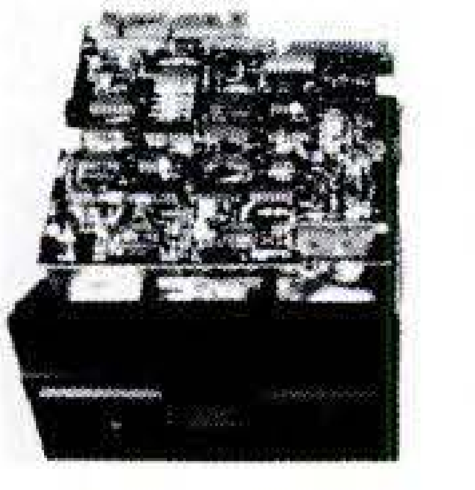
*Total capacity IBM unformatted with special software.
**Each unit supplied with two 3¼" flexible diskettes.

IBM FORMAT COMPATIBLE 3¼" DISK DRIVE



Tabor TC-500 drivette. Single-sided, quad density. Capacity:
Unformatted-250/500K bytes*
Formatted-164K bytes.
80 track/140 TPI, based on 16 sectors. Will work with any 5¼" disk controller.
Item **#8824** **$79.95**
*Total cap. 500K bytes with special software.

5¼" DISK DRIVE
96 TPI, DS/QUAD DENSITY FULL HEIGHT



Mfr — CDC #9409T
Item **#1893** **$99.00**

12/24 VDC 1" THIN MUFFIN-TYPE FAN

55/100 CFM, 8W. Can be mounted for blowing or exhaust. 5 plastic blades with feathered edges, aluminum housing. Brushless, ball-bearing type.
Dimen.: 4¹¹⁄₁₆" sq. x 1" deep
Mfr — Centaur CUDC24K4-601
Item **#8541** **$19.95**

240 CFM MAJOR® FAN

115 VAC/60 Hz.; .3 amps. Low noise, high pressure/volume fan for cooling in tight places. Five plastic blades with feathered edges, aluminum housing. Ball bearing, thermally protected. Permanent split capacitor motor (cap. built in).
Dim: 6¾"H x 5.92"W x 2"deep
Mfr — Rotron #MR2B3
Item **#6301** **$19.95** RFE

48-KEY KEYBOARD

Replace the membrane keyboard on your Timex/Sinclair Z-81/1000 with this brand new "big computer" keyboard from Texas Instruments. Simple to install — complete instructions and schematic included.
Item **#6712** **$5.95** New

9" HI-RESOLUTION (TTL) VIDEO MONITOR

Orange phosphor. Originally used in portable computers. 12 VDC.
Mfr — Phillips M24-308-LA/P
Item **#6811** **$19.95** New

BATTERIES

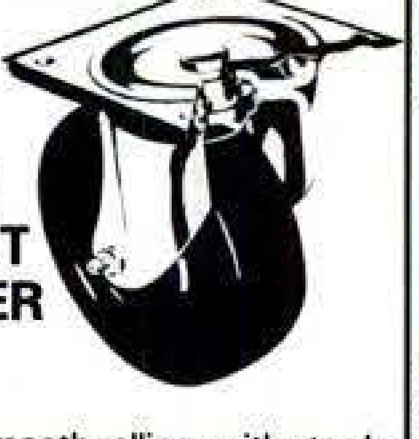
Nicad
12V @
450 ma

Contains 10 AA cells. Recharge rate: 45 ma. 16-18 hours. Case with tab output connections.
Dim.: 2¹⁄₁₆"H x 1¼"W x 2¹⁵⁄₁₆"L
Mfr — GE 123233 or equiv.
Item **#5443** **$9.95** RFE

Gel Cell
6V @
9.5 AH

For use with model cars, trains, boats, planes, etc.
Dim.: 5½"H x 4⅛"W x 2⅝"deep
Mfr — Elpower #695
Item **#7039** **$14.95** NEW

3" SWIVEL PLATE MOUNT CASTER SET



Durable, smooth rolling, with sturdy metal mounts. Can be used for shop equipment, engine stands, etc.
Plate Dimen: 2½" x 3¾"
Dim: 2⅜"dia. x 1¾"W x 3⅝"OAHt.
Mfr — Bassick Item **#7972**
set of 4 **$9.95** (used)

24 VDC POWER SUPPLY

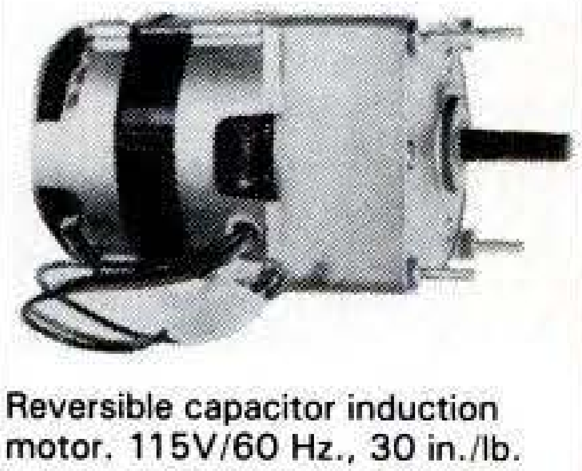
For robotics, motors, etc.
Variable output from 20-25VDC. Input: 105-125; VAC @ 60Hz. Maintains constant voltage output between 5 & 6 amps at rated input. AC fuse protection.
Size: 4" x 8½" x 7¾".
Mfr — Acme PS59134
Item **#62** **$19.95** RFE

PUMPS—COMPRESSORS—BLOWERS—MOTORS—POTENTIOMETERS—COUNTERS
TIMERS—RELAYS—VOLTAGE REGULATORS—POWER SUPPLIES

POOL CIRCULATING ½ H.P. MOTOR & PUMP ASSEMBLY

115 VAC/60 Hz/1; 30-40 GPM; non-self priming with power cord. Originally used as circulating pumps for pools — 12'dia. x 3'H.
Item **#7418** **$39.95**

55 RPM SATELLITE POSITIONING MOTOR



Reversible capacitor induction motor. 115V/60 Hz., 30 in./lb. torque. 14W. Front flange mount
OA Dim.: 3¼"D x 5"L.
Shaft: ⅜"D x 1"L.
Mfr — Matsushita or equiv.
Item **#5149** **$9.95** RFE

AIR COMPRESSOR

Produces up to 33 PSI. For air brush, paint spraying, tire & mattress inflation. 115VAC, 50/60 Hz. Capacitor-run motor.
Dimen.: 4⅝" dia. x 8¼" long
Mfr — Thomas Industries
Item **#65** **$29.95** RFE

200 CFM HI-VOLUME BLOWER

115 VAC/60 Hz., 1.5 amps., 3400 RPM. Thermally protected.
Outlet: 3½" x 2¾";
Inlet: 6⅞" dia.
Dim.: 10"H x 9"W x 7½" deep
Mfr — Fasco U85
Item **#26** **$12.95** RFE

AMERICAN DESIGN COMPONENTS, 62 JOSEPH STREET, MOONACHIE, N.J. 07074

MINIMUM ORDER $15.
PS-106

YES! Please send me the following items:

Item No.	How Many?	Description	Price	Total

Total
Shipping & handling, we ship UPS unless otherwise specified. Add $3 plus 10% total. Canadian: $3 plus P.O. cost. Charge only.
Sales Tax (N.J. residents only, please add 6% of total)
ORDER TOTAL

FREE CATALOG of electro-mechanical devices sent with every order.

☐ My check or money order is enclosed.
☐ Charge my credit card.
☐ Visa ☐ Master Card ☐ Amex
Card No.
Exp. Date
Signature
Telephone: Area Code Number
Name
Address
City
State Zip

All inquiries and free catalog requests call 201-939-2710.

For all phone orders, call **TOLL-FREE 800-524-0809.** *In New Jersey, 201-939-2710.*

vailing opinion that only perfect crystalline materials with a regular ordered structure were suitable for microelectronic applications ["Ovshinsky's Strange Devices: Semiconductors Made from Glass," PS, April '78]. He showed that substances amorphous in molecular structure—like glass—also function electronically.

Johnson uses Ovshinsky's amorphous silicon for a microelectronic device he labels an antifuse. A conventional fuse breaks a circuit if it carries too much current. The antifuse does the opposite. In its normal state, as a tiny region of amorphous silicon, the antifuse is nonconducting. But if you zap it with 20 volts of electricity, its molecular structure changes: Thereafter it conducts.

At Mosaic, Johnson first deposits a lattice of antifuses across his wafers. A crisscross array of conducting lines connects both conventional VLSI chips and antifuses. A CAD system determines which antifuses should be zapped to produce the right network of interconnections. Johnson starts by applying electricity at one corner of a wafer and working across. Each antifuse is at the intersection of two conducting paths. Shooting current through two paths activates a particular antifuse. The result is a dense array of conventional microchips on a single wafer, all electrically interconnected.

What are the advantages? Currently, packaged microchips are mounted on circuit boards and interconnected with printed wiring. Johnson mounts unpackaged microchips on a much finer grid of conducting lines formed on a silicon wafer; chip interconnections can have much greater density. And the technology lends itself nicely to automated production and testing. Such wafers can thus be much less expensive than circuit boards.

Still, Mosaic Systems' technique isn't real wafer-scale integration. Amdahl aimed at completely integrated wafers, but Johnson offers a clever method for wiring existing chips together. "Even we don't think it's the ultimate packaging," he says. After all, it faces the same limitations on mask-fabrication methods that laid Amdahl low.

Star Wars supercomputers

In terms of wafer-scale integration, there's considerable interest in the approach of Bruce McWilliams at Lawrence Livermore National Laboratory, near San Francisco. He uses lasers to write circuit patterns onto silicon.

McWilliams works in O Group, a team of exceptionally innovative researchers who have created much of the technical foundation for the Star Wars program of ballistic missile defense. Members of the group, which is located in a collection of trailers at Livermore, Calif., are often at their computer terminals throughout the night, particularly when research is going well.

McWilliams's goal: shrink a supercomputer onto a five-inch wafer. That's important for Star Wars, which requires powerful computers that can fit into a space weapon. To accomplish this, he's developing laser pantography: using a computer-controlled laser beam to produce local chemical reactions and deposit or remove material from a wafer.

To demonstrate how laser pantography can fabricate microcircuits, McWilliams places a silicon wafer in a vacuum chamber. A typical task is to form a new path of silicon on the substrate. First, silane gas, a silicon

Continued

We're YOUR Homeowner Headquarters for Top Quality Merchandise!

Garden Cart

Accomplish more in less time, less effort with this handy **Garden Cart.** • Heavy-duty steel front support system. • 250 lbs. cap. • 1/2" exterior grade plywood, weatherproofed. • 16" x 1.75 semi-pneumatic tires. • 2 sets of double steel bearings in each wheel. • Rust-proofed, metal parts. • Axle placement & wheel design assure perfect balance. • Overall: 48"L x 26"W x 21½"H. • Assembly required.

Box: 36"L x 20"W x 10"H

49⁸⁸

Compare at $95.00
Order No. C5264-1768
Shipping & Handling: $12.00

Famous Brand 5 HP Air Compressor

It's NOW available to You through a special volume purchase! Ideal for 100's of applications!!

Features: • 5 HP motor. • 230V, 15 amps. • Twin cylinder. • 932 RPM. • Air delivery: ACFM at 40/90 PSI - 11.8/9.4 • 125 lbs. max. pressure. • ASME rated 60 gal. tank. • Wt.: 340 lbs. • 28½" L x 23½"W x 71½"H. • Service centers nationwide. • **One yr. FREE parts replacement!**

Your LOW Price $466
Mail-in Mfg.'s Rebate —$20
Net Price after Rebate $446

Buy before Oct. 31, 1986 & qualify for a $20 Manufacturer's Rebate!

Rebate coupon will be sent with air compressor!

Order No. C5207-2094 Shipped Freight Collect

19,400 BTU Portable Kerosene Heater

Can be used as **primary heat** covering approx. 670 sq. ft.! Conveniently serves as **supplementary heat** and/or **emergency heat source** anywhere, anytime!

Features:
• 1.9 gal. tank. • 18 hrs. continuous heat. • Battery powered, pushbutton ignition, uses 2 "D" batteries (not incl.). • Auto. shut-off control. • Fiberglass wick. • Taupe & chocolate brown color. • 23"H x 18¾"Dia. • **1 yr. ltd. warranty!**

Wt.: 35 lbs.

$99

Mfg. Retail: $149.95
Order No. C5357-2250
S. & H.: $10.50

FREE PUMP! To 1st 500 Orders!

Compare our Price! This is the BEST Price in America!

Universal Aluminum Ladder

Second-story windows, clogged rain eaves, bothersome tree branches . . . it reaches wherever duty calls!

Use as 6' step ladder, 12' ladder, 2-man scaffold or fold to 90° angle to work in stairwells. Six specially designed hinges rotate to three positions & lock!

• Built to industrial standards. • Made of heavy gauge aluminum (800 lb. capacity). • Anti-slip rungs. • Molded rubber feet. • Folded: 23½"L x 9"W x 40½"H.

Wt.: 30 lbs.

89⁸⁸

Compare at $130.00
Order No. C5247-1310
Ship./Hand.: $14.00

TO PLACE AN ORDER please type or print clearly (on sheet of clean paper) the name & order no. of item(s) along with your name & address. Enclose a check or money order payable to **Wholesale America, Inc.** (be sure to add ship./hand. charges). You can also charge to MasterCard or VISA. Print the acct. no. & exp. date and sign your name. Allow 1-2 wks. for delivery. Add 2-3 wks. for clearing of personal checks and/or frt. collect items.

Send your orders to:

Wholesale America, INC.

Electric Start 6000 Watt Generator

Never be without electrical power again! • 8 HP **Briggs & Stratton** engine with electric start. • 1-120V duplex & 1-240V duplex receptacles, 36.7/18.3 amps. • 6000 watts surge, 4400 watts continuous power. • 29½"L x 20¾"W x 19½"H. • Wt.: 138 lbs. • **1 yr. FREE parts replacement warranty!**

60 Hz

$499

Order No. C5240-1034
Shipped Frt. Collect

2500 Watt Generator................. $368
Electric Start 8000 Watt Generator................. $999

10 DAY NO HASSLE GUARANTEE

If you're not completely satisfied with your purchase, return it (prepaid) within **10 days** for a FULL CASH REFUND (less shipping & handling). Returned product must be in original box and original condition.

4777 Menard Drive, Eau Claire, WI 54703

For credit card orders or more information call:

1-715-874-5000
— or —
1-800-826-3403

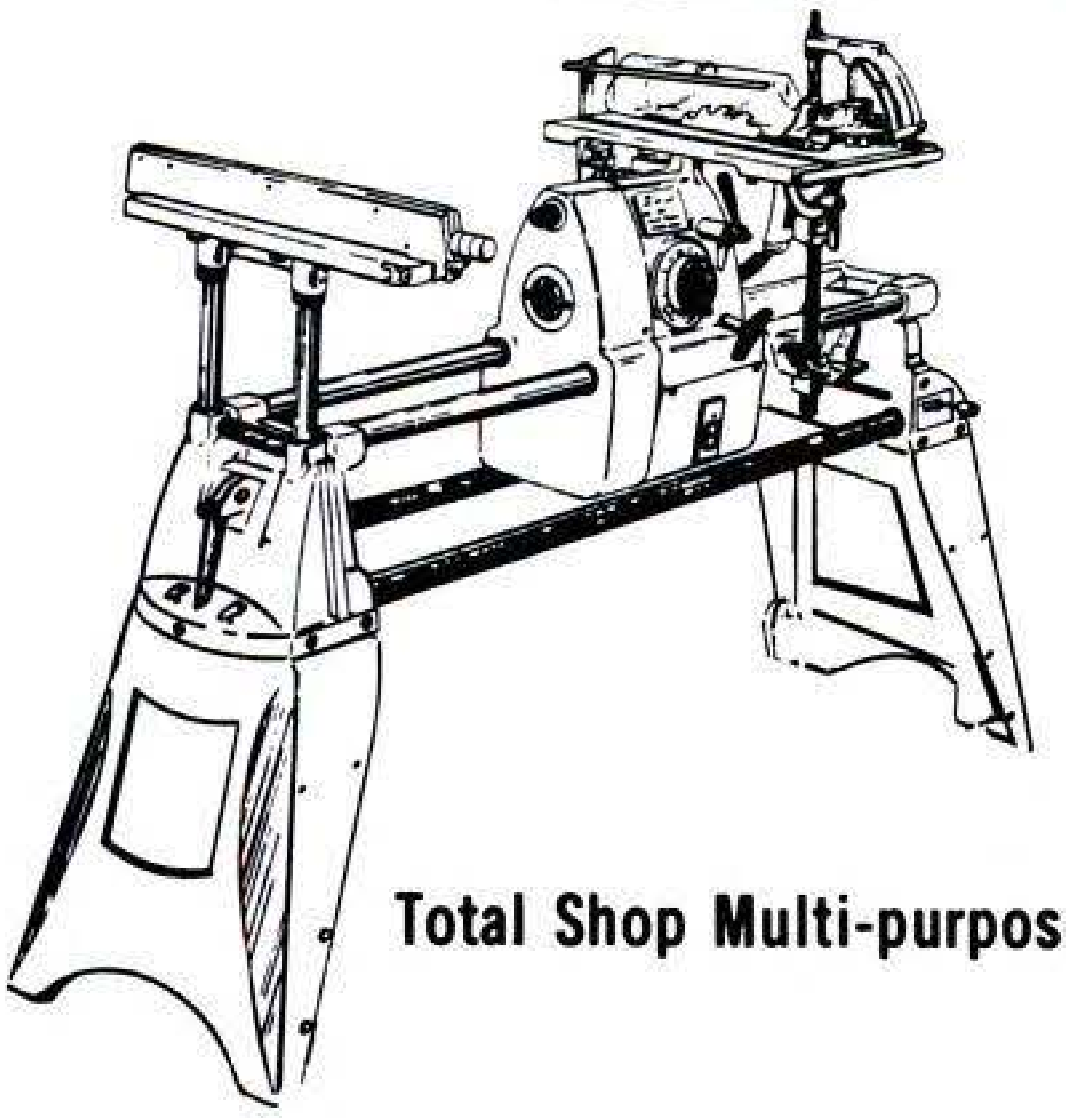
MasterCard VISA

Send $1.00 for the latest Money-Saving Catalog from Wholesale America!

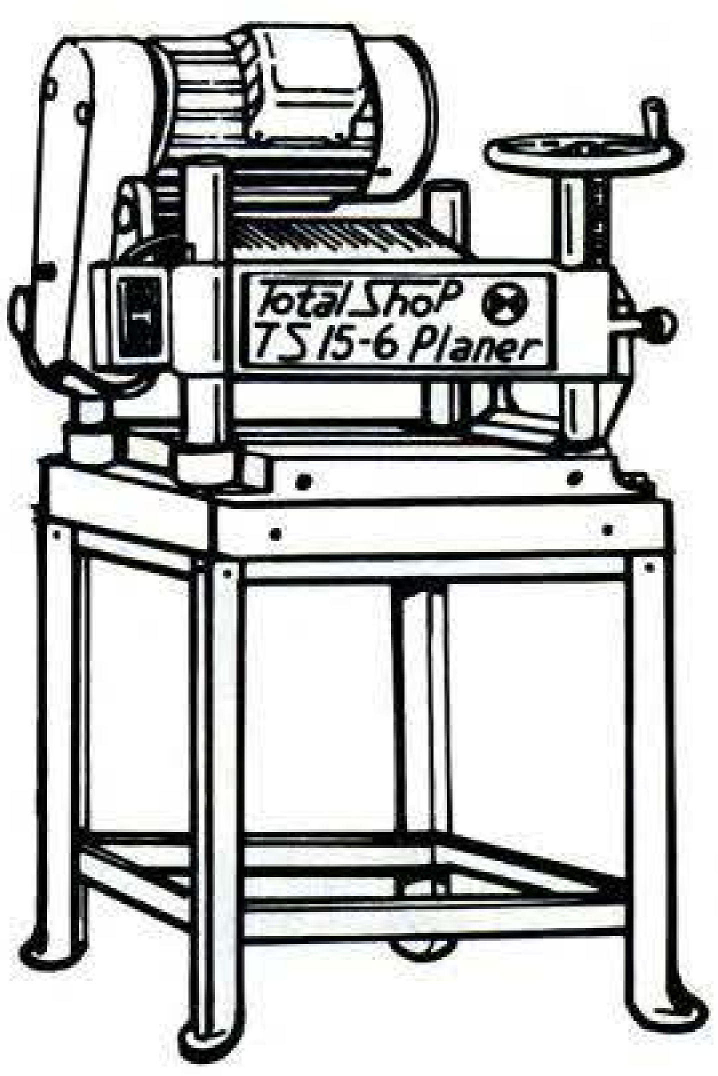
Includes Power Tools, Hardware & Housewares at unbelievably LOW, LOW Prices!

TotalShop®

The Shape of Pride



Total Shop Multi-purpose Tool



TS 15-6 Planer

What can compare to the sense of pride you feel when you carefully shape a piece of wood into a timeless treasure? Total Shop understands that feeling because we're proud too, and we have the shape to prove it. Our Total Shop multi-purpose tool and TS 15-6 planer are machines with solid power, versatility and stamina.

Compare Total Shop with Shopsmith® and see for yourself. The Total Shop motor produces nearly 40% more power than the Shopsmith® machine and can be altered by the owner to 220V, this is unavailable with Shopsmith® And in more than 85% of the comparisons, the Shopsmith® machine was priced higher than the Total Shop machine.

Don't overlook the TS 15-6 planer, a rugged machine convertible to 220V by the owner, optional stand and dust collector available, available with 2HP or 5HP motor, and a full 15" x 6" board capacity. A proud addition to any shop.

Our 30 minute video demonstration tape (available in VHS or Beta) gives you a look at our products in action before you buy. Send for it now (with a $20.00 refundable deposit) and you'll see what we've been boasting about.

Now available for ALL multi-tool owners! (Total Shop, Shopsmith®, etc.) **An informative 2½ hr. instructional video.** No matter what multi-purpose tool you own, you'll learn more about its set-up, care, and operation. Order today for only **$49.95** (available in VHS or Beta).

Experience the Shape of Pride.
Call
1-800-845-9356
(or in S.C. 288-4174)

and we'll send you 11 additional reasons why Total Shop is a better buy than Shopsmith® plus our free information pride packet.

☐ **YES!** Please send me your free information pride packet, with 15 reasons Total Shop is the better buy.
☐ Multi-purpose tool
☐ TS 15-6 Planer

☐ **YES!** Please send me the 30 min. demonstration video, I have enclosed a $20.00 refundable deposit.
☐ VHS
☐ Beta

☐ **YES!** I have enclosed $49.95 plus $2.00 shp. & hdl. for the 2½ hr. instructional video on the set-up, care , and operation of my multi-purpose tool.
☐ VHS
☐ Beta

Call Toll Free **1-800-845-9356** or in S.C. 288-4174

TotalShop®
Dept. F
P.O. Box 16297/Greenville, SC 29606

Name ____________________
Address ____________________
City ____________________
State/Zip ____________________
Phone ____________________

Copyrighted material

TECHNICAL BOOKS!

TESLA COILS!

TESLA COIL SECRETS
Page through the private notebooks of a builder of lightning bolt generators! Incredible diagrams and secrets! Rare info! paperback
Order no. 4317 $6.95

ALTERNATOR SECRETS
Get thousands of watts from common auto alternators! Run tools, lights, AC-DC appliances, charge batteries, do light arc welding and more! Jam-packed booklet!
Order no. 80 $3.00

RUN THREE PHASE MOTORS ON SINGLE PHASE POWER!
Learn three proven methods in use since the turn of the century! No motor rewinding! Easily done. Jam-packed booklet!
Order no. 81 $3.00

MACHINES

CURIOUS MECHANICAL MOVEMENTS
Explore a 1927 picture book of almost 1000 different mechanisms. Everything from unusual engines and acoustic telephones to mining devices and perpetual motion machines. Dynamite illustrations! Fascinating! Don't pass this up! 412 page paperback
Order no. 4406 $14.95

HISTORY OF PERPETUAL MOTION
Review man's attempt to build perpetual motion machines! From earliest types to the Keeley hoaxes! Well illustrated. Fascinating! 235 page paperback
Order no. 510 $5.95

MELT METAL

CHARCOAL FOUNDRY
Convert a five gallon pail into a powerful furnace to melt aluminum, pot metal, brass. Convert scrap into ingots and machine parts. Best selling paperback! 1980
Order. no. 163 $6.95

ORNAMENTAL METAL CASTING
Learn how you can cast decorative plaques, chess sets, banks, even fountains from scrap aluminum. Possible money maker! Best selling paperback! 1986
Order no. 4430 $7.95

Giant How-to Catalog!

Discover rare, top-rate paperbacks, textbooks, industrial references on all types of unusual how-to: foundry, machine shop skills, engine repair, electronics, alternate energy, homesteading, survival skills, much more! Send $1.00 ($3.00 foreign airmail) for your copy of our latest catalog — filled with more great books than we can fit in this ad! Or request free catalog with any book ordered from this ad!

HOW TO ORDER
Send your name, address, a list of the books you want, the total book cost, plus 75¢ for the first book and 25¢ for each additional to cover shipping and handling. We accept checks and money orders. Or send VISA or MASTERCARD numbers with signature. Illinois residents add 6% sales tax. All books are guaranteed! You may return any book within 7 days for refund. Your satisfaction is guaranteed! Order today!

Lindsay Publications, Inc.
PO Box 12-**FY**, Bradley IL 60915-0012

Write Today!

☐ Send a catalog! I've enclosed $1.00 ($3.00 foreign airmail).
☐ Send the books I've listed and a free catalog. I've enclosed 75¢ shipping for the first book and 25¢ for each additional.

Name ____________________
Address ____________________
City ____________________ State __________ Zip __________

Monster chips *Continued*

and hydrogen compound, whooshes into the chamber from a storage tank. Then a micron-size laser spot moves across the wafer, dissociating the gas just above the wafer and leaving fresh silicon in its path.

Depositing a line of tungsten metal is next. Excess silane is vented, and another gas, tungsten hexafluoride, flows into the chamber. Again the computer-controlled beam breaks down the gas, depositing a wispy thread of tungsten. The process continues, forming complex interconnected circuits on a wafer. To remove silicon or other metals from a wafer, fluorine or chlorine gas is introduced just above the disc surface, burning away minute areas of metal.

McWilliams's method produces circuit patterns on silicon equal to the best in the industry. New apparatus under construction will fabricate thousand-gate circuits (gates are fundamental logic circuits) in only six minutes.

And Livermore experts say that chip- or wafer-scale patterns will be formed by laser in less than a day. Laser pantography should also be able to test wafers in chambers, and locate and fix defects. By contrast, a single fault often ruins a microchip formed with conventional technology.

But its snail-pace fabrication rate is likely to limit laser pantography to specialized defense applications rather than consumer and business products. Military projects may require only a few hundred circuits or systems. Production runs for commercial chips are often in the millions. Laser pantography would be far too expensive for tomorrow's desk-top computers.

Winchester wafers

With highly specialized microcircuits, Britain's Clive Sinclair showed that wafer-scale integration is already possible. The firm he founded builds personal computers and flat-screen TVs. Sinclair's QL computer ["32-bit Business Computer," PS, April '84] originally used a tiny tape cartridge for data storage. But future models will use Sinclair's new memory wafer, which he calls a "solid-state Winchester," after the hard-disk memory system.

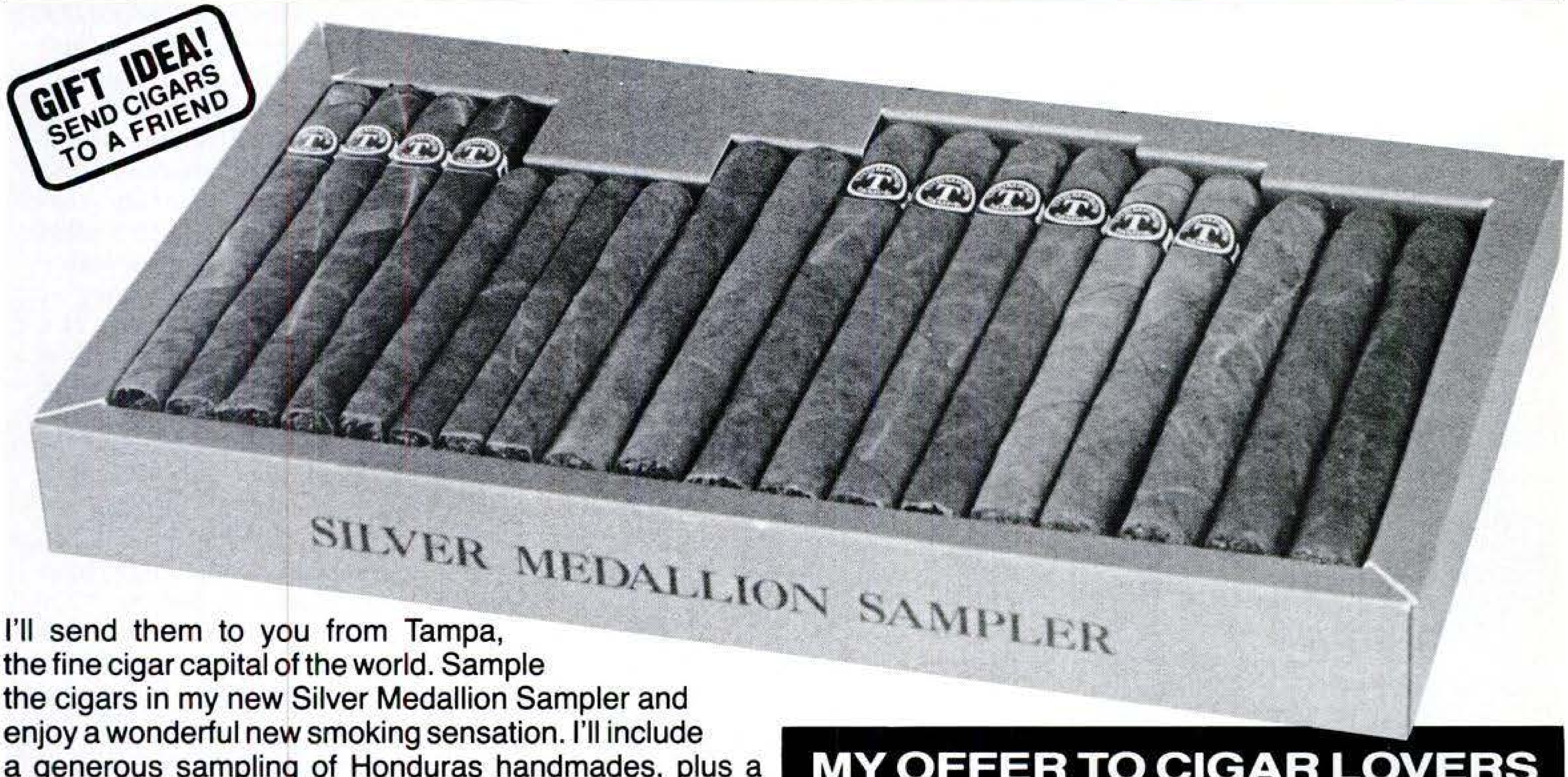
Sinclair's wafer has special memory cells, each linked to others on the wafer through logic circuits. The logic identifies good cells, then strings them together to create what amounts to long registers of memory. The technology, invented by Ivor Catt in the early 1970s, as Johnson describes it, "is very narrowly applicable to the small, powerful personal computers that Clive likes to make. It is not even extendable to a random-access memory [RAM]. It's a sequential-access memory. It's a disk replacement, not a RAM replacement."

To finally perfect wafer-scale integration, radically new design approaches may be necessary (see box). So far, researchers are nibbling at the edges of the problem. Trilogy's Amdahl tried, but his tools were inadequate. Mosaic's Johnson has succeeded, but his interconnection process amounts to a wafer-size circuit board, not a wafer-size microchip. Livermore's McWilliams is zeroing in on true wafer-integration technology, but it may serve only custom designs and small production runs. And Sinclair's highly specialized technology may only see limited use for computer memory.

Says industry pioneer Gene Amdahl: "It's not enough to make a revolution just in one area." PS

YOU DON'T NEED CASTRO'S PERMISSION TO SMOKE CUBAN-SEED HANDMADE CIGARS!

HANDMADES FOR THE MAN WHO THOUGHT HE COULDN'T AFFORD THEM!



I'll send them to you from Tampa, the fine cigar capital of the world. Sample the cigars in my new Silver Medallion Sampler and enjoy a wonderful new smoking sensation. I'll include a generous sampling of Honduras handmades, plus a nice selection of vintage-leaf, long-filler and cut filler cigars, all perfectly blended for mildness and flavor.

These superb smokes are made with expertly blended Cuban-seed-leaf tobaccos grown and cured the old Cuban way in Honduras from seed smuggled out of Cuba. They're mild, flavorful and extremely satisfying to the cigar smoker who's looking for something new, something better, something exceptionally tasty. Experts can't tell them from Havanas. You won't be able to either, when you try them. Natural wrapper. If you're ready for a luxuriously enjoyable smoking experience, try them now.

—"Yours is the only decent cigar I have had in over 12 years," one new customer wrote me the other day.

—"Of all the cigars I have smoked, both cheap and expensive, yours is the best of the bunch," wrote another.

—"Outstanding! Best cigars I have had since returning from overseas," wrote H. E. O., of Columbia, SC

—"I am very impressed with the mildness and freshness of the sampler you sent," said J. J. M., of Lincoln, IL

MY OFFER TO CIGAR LOVERS

I'll send you postpaid a selection of 42 factory-fresh cigars—a special selection of Honduras handmades, vintage-leaf long-filler and cut-filler smokes. If these cigars aren't all you expected, return the unsmoked ones by United Parcel or Parcel Post within 30 days and I'll refund your money. No questions asked. Your delivered cost is only $10.90 for 42 factory-fresh, Cuban-seed-leaf cigars.

To order, fill in and mail coupon to B595

THOMPSON CIGAR CO.
5401 Hangar Ct., Dept B595, Box 30303, Tampa, FL 33630

O.K., TOM! Ship me the Silver Medallion Sampler under your money-back guarantee for only $10.90.

☐ Check for $10.90 enclosed (Fla. residents add 5% sales tax)
☐ Charge $10.90 to my ☐ VISA ☐ American Express
☐ MasterCard ☐ Diners Club

Credit Card No. (Print all digits) Exp. Date

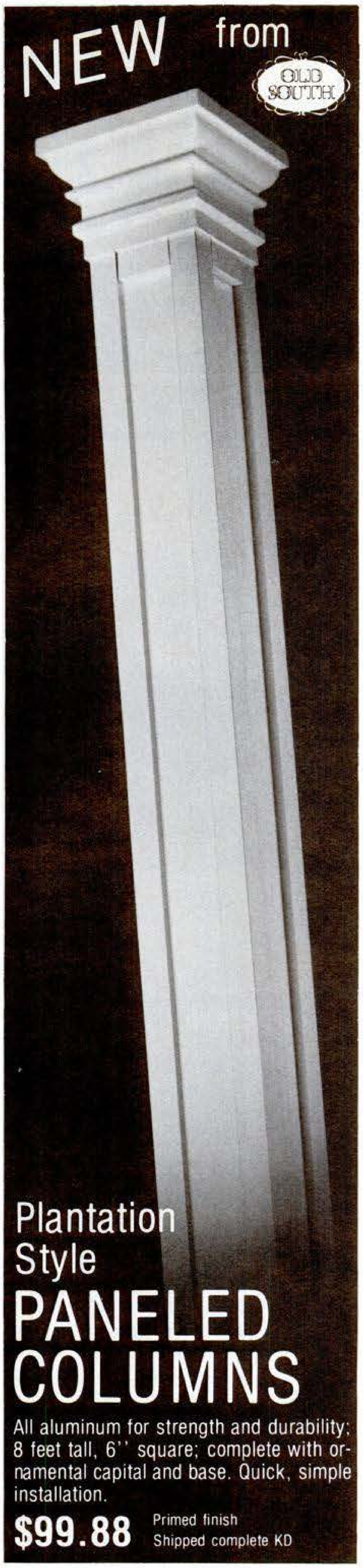
name

street

city state zip

OFFER GOOD IN U.S. ONLY

CREDIT CARD USERS SPEED DELIVERY BY CALLING **TOLL-FREE 1-800-237-2559**
IN FLORIDA, CALL 1-800-282-0646


NEW from OLD SOUTH

Plantation Style
PANELED COLUMNS

All aluminum for strength and durability; 8 feet tall, 6" square; complete with ornamental capital and base. Quick, simple installation.

$99.88 Primed finish
Shipped complete KD

Moultrie Manufacturing Co.

P.O. Box 1179 - Moultrie, GA 31776-1179
Call Toll-Free 1-800-841-8674

21st-century superfighters

[Continued from page 86]

different airplanes that had hundreds of different combinations of radar signature, speed, maneuverability, and types of avionics. Then we simulated battles and looked at how many enemies we shot down and how many airplanes we lost [see drawing]. That's called the exchange ratio, the ratio of reds to blues. Then you plot those exchange ratios versus the different parameters. In one plot you'll see that you traded some stealth for some maneuverability. In another, you traded some maneuverability for some stealth. Getting the best balance is what gives you the best airplane for the job.

"We spent three years talking to the Air Force about what can be accomplished. We look at it as Ping-Pong. The Air Force is refining its requirements while we're looking at our designs. We show their people our designs and simulation analyses, and they go back and look at their requirements again," Hardy says, seesawing his hands up and down.

"You have to pick and choose very carefully what you put on the airplane," Hardy continues. "You don't get anything for free. Everything weighs something. A lot of things have drag. Some components displace other subsystems, or they increase the volume of the airplane. You want to make the maximum cross-sectional area as small as possible, because that affects drag. But everything you stuff in the airplane makes it bulge. There are a lot of tough compromises."

Variable wing camber

Boeing is working on one of the most exciting future-fighter research projects: modifying the wings of an F-111 fighter so that they can change their camber, or curvature, in flight to optimize performance under varying conditions (see drawing on opening pages). Ronald DeCamp, who manages the joint Air Force-NASA program at Wright-Patterson AFB, explains where the mission-adaptive wing idea originally came from.

"This wing actually does what a bird's wing would do. Birds are so phenomenal. They change the camber, sweep, and angle of incidence of their wings without even thinking about it. The Wright brothers used a warping-wing approach for lateral control on their first airplane," he says. "We feel that versions of this will be adapted for all future aircraft, including airliners."

The high-strength yet springy fiberglass leading and trailing edges of the experimental F-111's wings are flexed by computer-controlled actuators located inside the wings. DeCamp describes how the system achieves best cruise efficiency: "It optimizes the wing shape for total-aircraft minimum drag. The way it does this is by deflecting the wing surfaces until the aircraft velocity reaches its maximum at a given throttle setting and altitude. The search is automatic."

"At some speeds, we are increasing lift by more than a hundred percent," DeCamp reports. "It's amazing how little this wing has to recontour to give a dramatic improvement in its efficiency. Full-down setting is used at leading and trailing edges for landing. For subsonic cruise, it uses two degrees trailing edge and zero degrees leading edge. At supersonic speeds, it wants to eliminate the camber, and even lift the trailing edge up slightly."

Another camber mode, called maneuver-load control, will be tested next year. It will actually increase the wing's G-load capability, De Camp explains. "In this mode, as the pilot turns tighter, wing camber increases at the wing's root while decreasing at its tip. In a conventional wing, the wing tip acts as a lever that can put high bending loads on the rest of the wing. We want to shift the aerodynamic loads away from the wing tip toward the much stronger root. As a result, the wing is less likely to exceed its design limit and break."

Lockheed is also taking a hard look at variable-camber wing designs. "Our aerodynamicists are very excited about them. From an aerodynamic viewpoint, it's like having your cake and eating it too," explains Mullin. "We have built several wind-tunnel models, and we think we understand the technology. Now we've got an internal design contest going. One group is trying to develop fixed-geometry wings that will give good performance across the full flight regime. Another group is refining mission-variable wings. We'll look at the results and then decide."

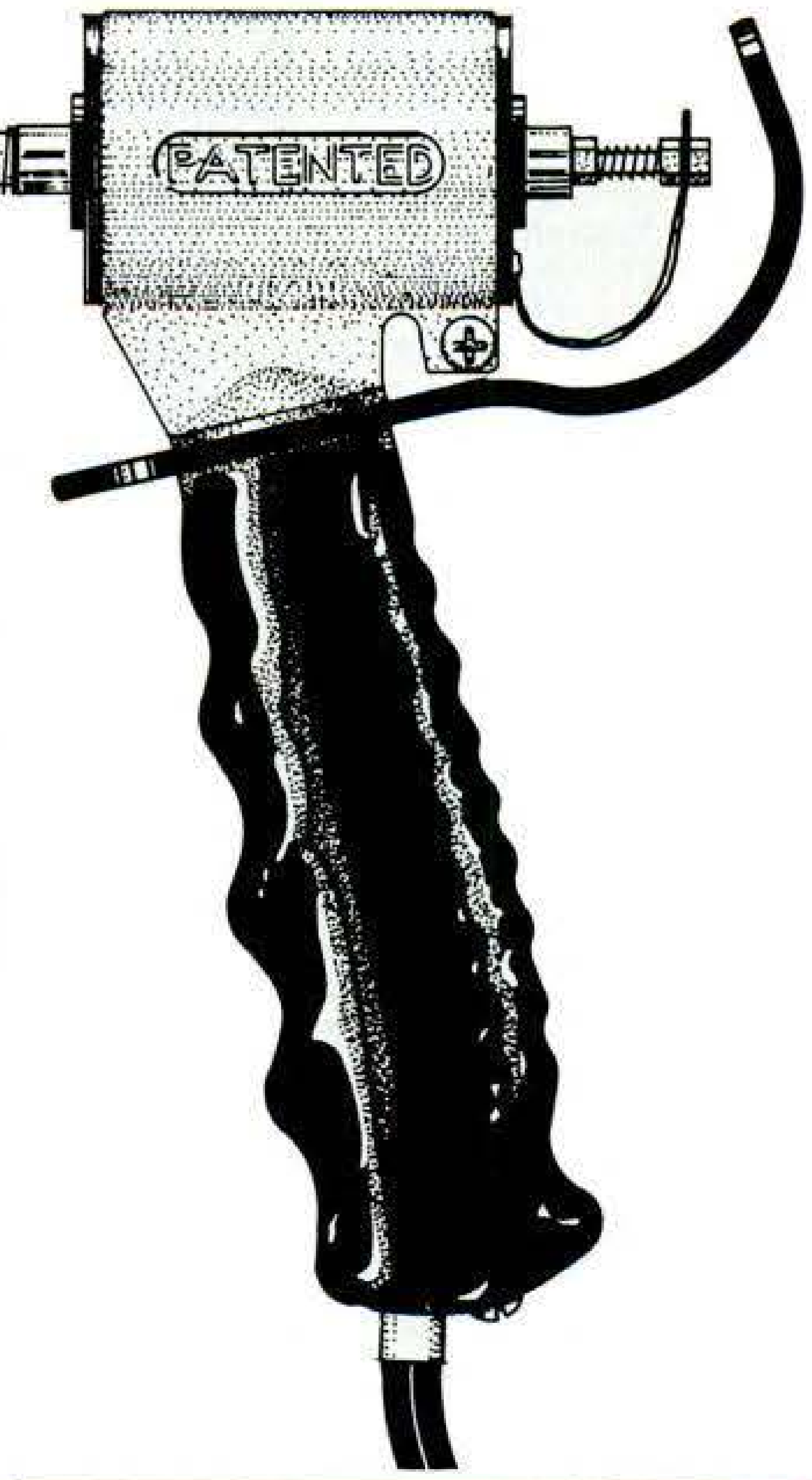
Thrust vectoring and canards

Handing me a wooden model of an airplane-to-be, Lt. Col. Richard A. Borowski points out the two external features that set this highly-modified F-15 apart from the standard version. "It will have canards in front and two-dimensional thrust-vectoring exhaust nozzles. Both of these devices complement the existing wings, tails, and horizontal stabilizers to provide more ways to control the airplane," he says.

This fighter, called the short takeoff and landing and maneuvering technology demonstrator (SMTD), will prove out some of the major features the Air Force is considering for the

Continued

New Stitch Welder Tames Sheetmetal Distortion



Our Customers Write:

"Before buying your Stitch Welder I was ready to throw my electric welder in the trash. No matter how hard I tried, the amps could not be set low enough to prevent burning holes in the sheetmetal. I now have a useable piece of equipment thanks to your Stitch Welder."

J. Wright, Penna.

Simplifies Home Bodywork

With a little practice anyone can weld automotive sheetmetal with virtually no distortion or burn-through. The Stitch Welder makes it easy to run a continuous weld bead on quarter panels, body patches, floor boards, etc. If you've ever tried arc welding body panels you know the high amperage output plays havoc on thin gauge metal. Our new Stitch Welder controls amperage to produce professional, uniform welds similar to those made by expensive wire-fed MIG machines.

Special Circuits Control Arc Welding

By directing the arc welder's current through a copper wound solenoid and diode the Stitch Welder creates a unique pulsing action. This pulsed current produces an easy-to-control arc necessary for clean, uniform weld beads on sheetmetal. There are no buttons or triggers — the pulsing action is automatic! All you do is guide the electrode.

Welding with the Stitch Welder is faster and easier than conventional stick welding. The arc's self-starting, so there's less chance of rod sticking. Once you strike an arc lay the rod on the metal and let the machine do the work. After some practice you'll produce welds requiring little grinding or filling. Remember, as with any welding tool the Stitch Welder requires practice to produce good results. We've included complete detailed instructions.

Attaches to Any A.C. Welder

The Stitch Welder's five-foot power cord attaches to the electrode holder on any A.C. arc welder (must run at 80 amps or less). Uses standard arc welding rods up to 3/32″ and will weld down to 22 gauge steel and stainless. The tool body is cast aluminum with a vinyl insulated grip for positive control. Electrodes held with a set screw and can be easily replaced. Tool designed for years of trouble-free service. ALWAYS USE PROPER SAFETY PRECAUTIONS WITH ANY WELDING EQUIPMENT.

30 Day Shop Trial

Try the Stitch Welder for 30 days in your shop or garage. If you are not completely satisfied, simply return it for a full refund. Order your Stitch Welder now for a head start on body work projects. The Stitch Welder is only $59.95 plus shipping. Available only through Eastwood.

TO ORDER CALL TOLL FREE:

1-800-345-1178

For fastest service call toll-free 1-800-345-1178 (in PA, 215-644-4412) and charge your Stitch Welder to Visa, MasterCard, or C.O.D. ($2.75 additional fee on C.O.D.) Mail orders use coupon.

© Copyright 1985 The Easthill Group

Eastwood

Code 1D37PSA6

☐ Send me ______ #4369 Stitch Welders at $59.95 plus $4.95 shipping & handling

☐ #4372 Arc Welding Rods Designed for Sheetmetal. 2mm dia., special flux, 3 lb. pkg (approx. 120 rods) — **$9.95**

☐ Send Free 80 Page Tool Catalog

☐ Check Enclosed ☐ C.O.D. ($2.75)

☐ VISA ☐ MasterCard

Card # ______

Expiration Date ______

Name ______

Address ______

City ______

State ______ Zip ______

Pa. Residents, Add 6% Sales Tax

The Eastwood Company
147 Pennsylvania Avenue
Box 296
Malvern, PA 19355

This VET Did It – and YOU Can Do It Too!

"War injuries left me badly handicapped, but now I'm a financial success as a Locksmith, thanks to your training. Besides, the work is fascinating. If I can do it anybody can." — Glen Johnson, Larned, Kan.

Make Up to $26.00 an Hour — even while learning!

Train FAST at Home! Be a LOCKSMITH!

If you enjoy fixing things, you're a "natural" to make hundreds of EXTRA DOLLARS a year in the fascinating business of Locksmithing. Rising crime has increased demand for service a thousandfold. **Yet there's only one Locksmith for every 17,000 people!**

COLLECT CASH PROFITS ALMOST AT ONCE!

You're "in business" ready to make $10 to $26.00 an hour a few days after you begin Foley-Belsaw's shortcut training. Easy illustrated lessons complete with ALL practice equipment **PLUS**

- **ALL TOOLS YOURS TO KEEP**
- **KEY MACHINE YOURS TO KEEP**
- **EXPERT PERSONAL ASSISTANCE**
- **BUSINESS-BUILDING HELP**

enable you to get your share of this always-profitable business. Hundreds we've trained are doing it. So can YOU.

MAIL COUPON to discover how Locksmithing can keep the extra money coming in during spare time — or in your own full-time business. Ideal for retirement—good jobs, too.

FOLEY-BELSAW INSTITUTE, 11010 Field Bldg.
Kansas City, Mo. 64111

N. Hunt, Wilmington, Del.—"I make $50 a week extra."

R. Davis, St. Louis, Mo.—"I cleared $110 last Saturday."

Ed Boyle, Pittsburgh, Pa.—"My business going at top speed. I'm moving to bigger quarters."

KEYS TO YOUR FUTURE FREE

MAIL THIS COUPON • NO SALESMAN WILL CALL

FOLEY-BELSAW INSTITUTE, 11010 Field Bldg.
Kansas City, Mo. 64111

FOLEY BELSAW

Rush **FREE** book, "Keys to your Future."

Name__________

Address__________

City______ State______ Zip______

THIS DO-ALL PRO KEY MACHINE YOURS TO KEEP!

Can add $50 to $100 a week to your income... and doesn't cost you a penny extra!

FREE

HOT OR COLD

EASY STARTS

Hot weather . . . When you shut your engine down on a hot summer day, particularly after a Turnpike run, it's often hard to start. Hot parts expand and pinch together. TUFOIL's super low friction helps you get going easier. **Cold weather** puts a big strain on your battery and starting motor. Recent Canadian government and independent tests in Michigan verify improvements when TUFOIL is used. Cranking speed for gas engines improved 6.1% . . . diesels 9.6% . . . and a 5% fuel savings too. Six U.S. patents so far! Make winter and summer driving easier.

Use TUFOIL . . . your engine will run better, last longer!

Tufoil
for ENGINES
•Better Mileage
•Better Performance
•Easier Starting
•Increased Engine Life
•Fewer Oil Changes
•Proven, Tested Guaranteed
8 FL OZ

ORDER
TOLL-FREE
24 hours a day
7 days a week
1-800-922-0075
In New Jersey,
(201) 825-8110.

When POPULAR MECHANICS tested TufOIL, it reported gas savings of 10.3%. And they wrote "TufOIL is "absolutely spectacular"... There are lots of slick oils on the market, but we've found one that does what it promises."

Fluoramics, Inc.
103 Pleasant Avenue PS-106
Upper Saddle River, N.J. 07458

YES! Send me a risk-free supply of TUFOIL

☐ One 8 oz. bottle $ 14.25 (plus $3.50 shipping)
☐ Two 8 oz. bottles $ 25.00 (plus $4.00 shipping)
☐ One gallon $125.00 (plus $6.00 shipping)

My check or money order for $ _____ is enclosed
Charge my credit card
☐ Am. Express ☐ MasterCard ☐ Visa

Card No. __________
Exp. Date __________
Signature __________
Name __________
Address __________
City __________
State ______ Zip ______

(NJ residents please add 6% sales tax.) Orders to Canada send check or money order in U.S. currency. Add $4 extra shipping charge.

FREE ☐ It's impossible to tell the whole TUFOIL story on one page. We have prepared a simple 4-page brochure that will answer many of your questions. Just check the box and give us your name and address above.

21st-century superfighters

Continued

ATF. It is scheduled to make its first flight in March of 1988.

Adding canards is a way to increase the F-15's G-load capability in turns from 7.3 to 9.0 G without modifying its wings (see drawing). "Nine G's hurts. You come back from those flights with broken blood vessels on the bottoms of your forearms. It's a physically difficult thing to do, but it's better than getting hit by a missile," Borowski observes.

Actuators in the rectangular exhaust nozzles move the top and bottom surfaces up and down, providing pitch control by directing the engines' thrust at an angle above or below the horizontal (see diagram). By using various combinations of control inputs at the canards, wings, horizontal stabilizers, and exhaust nozzles, "you can make the airplane go up without pointing up, or point up without going up," maneuvers that can be useful during landings or for aiming cannons in combat, Borowski explains.

One of the big payoffs of the new exhaust-nozzle design will be its thrust-reversing capability. "We want to be able to land the airplane on only 1,250 feet of runway, which may be all you've got if you have to land at a bomb-damaged airfield," Borowski says.

The invisible part of the SMTD F-15 is its digital flight-control electronics. Despite the airplane's increased number of maneuvering systems, "There will be no extra controls in the cockpit. The pilot will have the same stick and throttle. All of these extra control complexities will be transparent to him," Borowski says. "Everything that controls the engines and exhaust nozzles will be tied together with everything that runs the flight-control surfaces. The software will handle it all."

The more I learned from the two dozen experts in the military and the aerospace industry I interviewed about the ATF program, the clearer it became that advanced aircraft have come to depend completely on electronics. The electrons dashing through all those circuits and wires are now as important to the pilot as the molecules of air that give lift to wings and make flight controllable. A cost breakdown of the fighter's projected $35-million-per-copy price tag shows how important all the black boxes have become. "The biggest share of the cost is in the avionics," says Richard Hardy at Boeing. Without these fast and powerful computer and sensor systems, pilots would never be able to cruise supersonically for long distances or make smart decisions from the God's eye perspective. PS

Eliminate Noise Pollution

Is Your Job Performance Suffering Due to Lack of Sleep

Are YOU feeling the adverse effects of the sedatives necessary to get a good night's sleep? Do YOUR family members and co-workers find you irritable and tense?

NOW . . . you no longer have to consider relocating to escape the noise pollution of the city; nor, do you have to take sleeping aids to induce sleep.

Ambient Shapes Offers A Great Escape — The Marsona 1200 Sound Conditioner.

Condition Your Environment

Just as the Floridian controls his hot environment with *air* conditioning, you can control your noisy environment with *sound* conditioning . . . but noise is NOT restricted to the "Sunbelt". Noise pollution is everywhere.

Sound — Noise The Dangerous Difference

Webster describes sound as a disturbance in the pressure and density of air, capable of being detected by the organs of hearing.

Noise is stimulated by sound waves of irregular and unrelated frequencies. Noise is such a serious social problem that in some cities it is against the law to sound an automobile horn except in an emergency and in most cities it is against the law to drive a car without a muffler. Additionally, police action may be taken against those persons persistently playing radios and televisions during all hours of the day and night.

Noise Affects You

Noise produces discomfort, irritability, and distraction. Loud and intermittent noises tend to produce sudden changes in blood pressure, gastric secretion, pulse rate, perspiration, respiration, and muscle tension. Obviously, noise control not only concerns our health and comfort, it concerns our pocketbook. Is the noise pollution in your environment causing you to be irritable? Are you awake endless hours of the night because of continual disturbances and distractions? Many psychological tests verify that a loss of sleep is followed by inefficient performance. Intelligence test scores are reported to drop by almost 25 percent due to sleep deprivation along with a decrease in muscle control.

SURF I
SURF II
RAIN
WATERFALL
SELECTOR
TREBLE
BASS
TONE
SLOW
FAST
RATE
LOW
HIGH
RANGE
ON
OFF
VOLUME
marsona 1200

The Noise Neutralizer

The Marsona 1200 simply neutralizes and modifies sounds that are typically distracting or disturbing. With four realistic, synthesized sound selections, "Surf I" a steady wave pattern, "Surf II" a random wave pattern, "Rain", and "Waterfall", along with tone, volume, surf rate and surf range control, the Marsona 1200 creates a tranquil environment by masking disturbances from those partying neighbors, barking dogs, playing children, or snoring spouse. Because it weighs less than three pounds, you can conveniently take the Marsona 1200 with you on business trips. Accommodating both 110 and 220 V, the Marsona is ready for international travel too. Further, you can connect the Marsona 1200 to your stereo system for such a realistic sound, you can let your imagination run wild as you travel from the mountains to the sea shore. Use the Marsona sound conditioner to promote much needed sleep in turn promoting a much more likeable and a much more healthy you. You will NEVER need to use sleeping pills again.

These satisfied customers offered their comments on the MARSONA 1200 Sound Conditioner:

- *"Used in dental office to mask sounds of high speed turbines and relax patients and staff."*
  Dr. D. B., Oak Park, IL
- *"Fabulous technology & quality On Wave II, I can feel the sand between my toes."*
  L. C., Chapel Hill, NC
- *"It also helps to create a romantic environment . . ."*
  Ms. J. H., Baton Rouge, LA
- *"Fantastic - Best sleep in years - got rid of headaches from lack of sleep - more energy"*
  M. B., N. Hollywood, CA
- *"This instrument has effectively solved all noise pollution problems . . . indispensable."*
  J. S., Manalapan, NJ

ORDER TOLL FREE

24 Hours Seven Days A Week

Major credit card holders please call toll free. Order product **#PMA120** for the Marsona 1200. Or send a check for **$129.00** (FREE Shipping). NC residents add 4.5% sales tax. One (1) year warranty - Thirty (30) day money back guarantee.

ORDER TOLL FREE TODAY

800/438-2244

NC residents call 704/324-5222

Ambient Shapes.

Ambient Shapes, Inc.
P.O. Box 5069
Hickory, NC 28603

The Foldable, Portable, Storable Tan

PRO TAN

Home Sunsystem™

• Exclusive lightweight design folds 9" flat for storage. • Get a professional tan anytime, anywhere. • Guaranteed tan without sweating or burning. • Keep a rich tan year-round—without the sun.

30 DAY MONEY BACK GUARANTEE

$995 VALUE NOW ONLY $749

86POP4

FREE Full-Color Brochure • CALL 305/888-8415 • Fast Delivery

Name:
Address:
City:
State
Zip

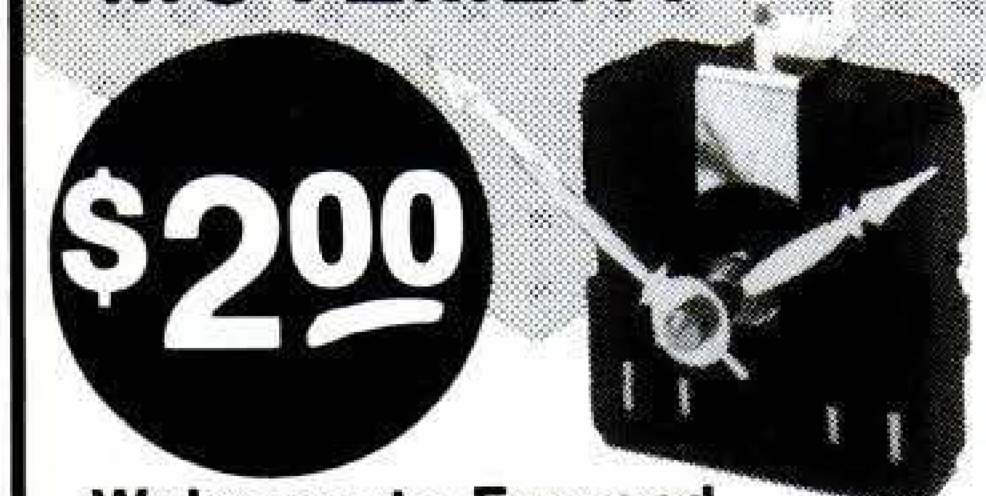
MasterCard VISA

High tech European design complements any bedroom or exercise room

MADE IN USA

Welt Industries, 870 W. 25th St., Hialeah, FL 33010

QUARTZ CLOCK MOVEMENT



$2.00

Welcome to Fun and Profitable Clockmaking

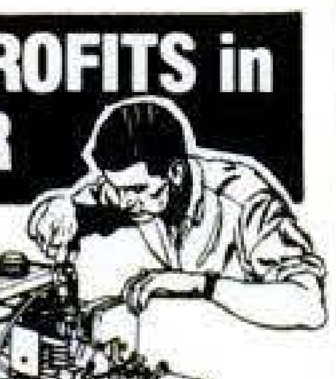
We offer the finest quartz movements made in America! Thousands of people enjoy this popular hobby—making and repairing clocks, as well as to earn extra income. This movement sells for $6.50 plus shipping...but as an introductory offer you may purchase a sample for $2.00 INCLUDING shipping/handling. You'll also get FREE: hour and minute hands, 56 page catalog and "Clockmaking Ideas" pamphlet. Don't delay.. your order must be postmarked by 11/30/86. Sorry no foreign, credit card or C.O.D. orders.

Name ____________
Address ____________
City, State, Zip ____________

KLOCKIT DEPT. PS106
P.O. Box 542
Lake Geneva, WI 53147

Original Coupons Only—No photostats.
Allow Three Weeks for Delivery.

NOW! Get in on the PROFITS in SMALL ENGINE REPAIR



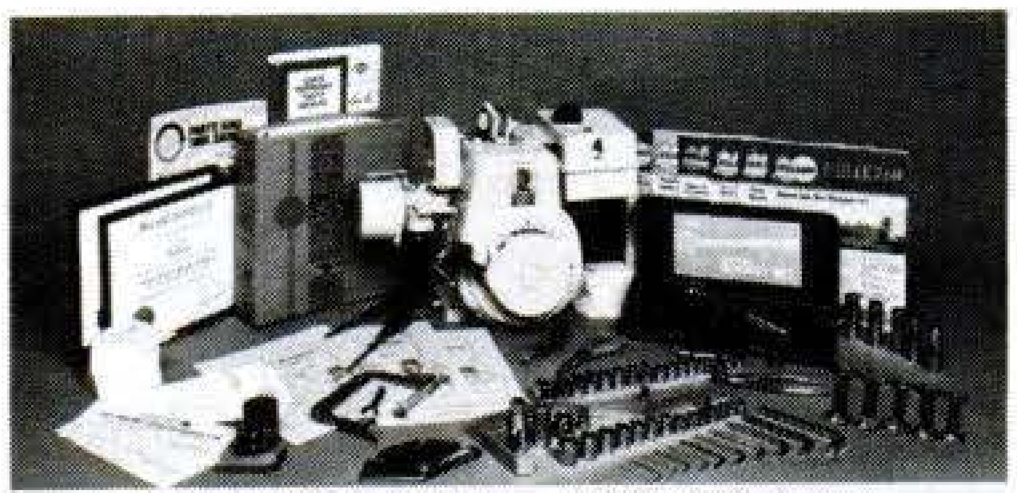
Start your own money making business!

Work part time, full time — right at home — we help you every step of the way.

No doubt about it . . . as a small engine pro, you can cash in on the huge demand for qualified men in one of America's fastest growing industries. You'll be able to command top hourly rates of from $25.00 to $30.00 per hour — and that's just for labor.

Plenty of business waiting for qualified men. 65,000,000 Small Engines Are In Use Today!

That's the official count from the Engine Service Assn., and one-million new engines are being built each month. With Foley-Belsaw training, you can soon have the skill and knowledge to make top money servicing these engines.



Professional Tools and Equipment PLUS 4 hp Engine . . . .
All YOURS TO KEEP . . . . All at No Extra Cost.

NO EXPERIENCE NECESSARY!

You don't need to be a 'born mechanic' or have any prior experience. Lessons are fully illustrated . . . so clear you can't go wrong, and with our famous 'learn-by-doing' method you get practical 'hands-on' experience.

Foley-Belsaw Institute • 51008 Field Bldg.
Kansas City, Mo. 64111

☐ YES, please send me the FREE booklet that gives full details about starting my own business in Small Engine Repair. I understand there is No Obligation and that No Salesman will call on me.

FREE BOOKLET! Send for your copy today!

NAME ____________
ADDRESS ____________
CITY ____________
STATE ____________ ZIP ____________

Voyager's triumph

[Continued from page 79]

urn system, Voyager 1 was flung on a path that will never encounter any other known world; but Voyager 2 flew to Uranus with brilliant success, and is now on its way to an August 1989 encounter with the Neptune system. At these immense distances, sunlight is getting progressively dimmer, and the spacecraft's transmitted radio signals to Earth are getting progressively fainter. These were predictable but still very serious problems that the JPL engineers and scientists also had to solve before the encounter with Uranus.

Because of the low light levels at Uranus, the Voyager television cameras were obliged to take longer time exposures. But the spacecraft was hurtling through the Uranus system so fast (about 35,000 miles per hour) that the image would have been smeared or blurred—an experience shared by many amateur photographers. To overcome this, the entire spacecraft had to be moved during the time exposures to compensate for the motion, like panning in the direction opposite yours while taking a photograph of a street scene from a moving car. This may sound easier than it is: You have to compensate for the most casual of motions. At zero gravity, the mere start and stop of the on-board tape recorder that's registering the image can jiggle the spacecraft enough to smear the picture. This problem was solved by commanding the spacecraft thrusters, instruments of exquisite sensitivity, to compensate for the tape-recorder jiggle at the start and stop of each sequence by turning the entire spacecraft just a little. To compensate for the low received radio power at Earth, a new and more efficient digital encoding algorithm was designed for the cameras, and the radiotelescopes on Earth were joined together with others to increase their sensitivity. Overall, the imaging system worked, by many criteria, better at Uranus than it did at Saturn or even at Jupiter. The ingenuity of the JPL engineers is growing faster than the spacecraft is deteriorating.

And Voyager may not be done exploring after its Neptune encounter. There is, of course, a chance that some vital subsystem will fail tomorrow, but in terms of the radioactive decay of the plutonium power source, the two Voyager spacecraft will be able to return data to Earth until roughly the year 2015. By then they will have traveled more than a hundred times Earth's distance from the sun, and may have penetrated the heliopause, the place where the interplanetary magnetic field and charged particles are replaced by their interstellar counterparts; the heliopause is one definition of the frontier of the solar system.

Robot-human partnerships

These engineers are heroes of our time. And yet almost no one knows their names. I have attached a table giving the names of a few of the JPL engineers who played central roles in the success of the Voyager missions. In a society truly concerned for its future, Don Gray, Charlie Kohlhase, or Howard Marderness, would be as well known for their extraordinary abilities and accomplishments as Dwight Gooden, Wayne Gretzky, or Kareem Abdul Jabbar are for theirs.

Voyager has become a new kind of intelligent being—part robot, part human. It extends the human senses to far-off worlds. For simple tasks and short-term problems, it relies on its own intelligence; but for more complex tasks and longer term problems, it turns to another, considerably larger brain—the collective intelligence and experience of the JPL engineers. This trend is sure to grow. The Voyagers embody the technology of the early 1970s; if such spacecraft were to be designed in the near future, they would incorporate stunning improvements in artificial intelligence, in data-processing speed, in the ability to self-diagnose and repair, and in the capacity for the spacecraft to learn from experience. In the many environments too dangerous for people, the future belongs to robot-human partnerships that will recognize Voyager as antecedent and pioneer.

Unlike what seems to be the norm in the so-called defense industry, the Voyager spacecraft came in at cost, on time, and vastly exceeding both their design specifications and the fondest dreams of their builders. These machines do not seek to control, threaten, wound, or destroy; they represent the exploratory part of our nature, set free to roam the solar system and beyond. This kind of technology, its findings freely revealed to all humans everywhere, is one of the few activities of the United States admired as much by those who find our policies uncongenial as by those who agree with us on every issue. Unfortunately, the tragedy of the space shuttle Challenger implies agonizing delays in the launch of Voyager's successor missions, such as the Galileo Jupiter orbiter and entry probe. Without real support from Congress and the White House, and a clear long-term NASA goal, NASA scientists and engineers will be forced to find other work, and the historic American triumphs in solar-system exploration—symbolized by Voyager—will become a thing of the past. Missions to the planets are one of those things—and I mean this for the entire human species—that we do best. We are tool makers—this is a fundamental aspect, and perhaps the essence, of being human.

Greeting the aliens

Both Voyager spacecraft are on escape trajectories from the solar system. The gravitational fields of Jupiter, Saturn, and Uranus have flung them at such high velocities that they are destined ultimately to leave the solar system altogether and wander for ages in the calm, cold blackness of interstellar space—where, it turns out, there is essentially no erosion. Once out of the solar system, the surfaces of the spacecraft will remain intact for a billion years or more, as the Voyagers circumnavigate the center of the Milky Way galaxy.

We do not know whether there are other space-faring civilizations in the Milky Way. And if they do exist, we do not know how abundant they are. But there is at least a chance that some time in the remote future one of the Voyagers will be intercepted by an alien craft. Voyagers 1 and 2 are the fastest spacecraft ever launched by humans; but even so, they are traveling so slowly that it will be tens of thousands of years before they go the distance to the nearest star. And they are not headed toward any of the nearby stars. As a result there could be no danger of Voyager attracting "hostile" aliens to Earth, at least not any time soon.

So, it seemed appropriate to include some message of greeting from Earth. At NASA's request, a committee I chaired designed a phonograph record that was affixed to the outside of each of the Voyager spacecraft. The records contain 116 pictures in digital form, describing our science and technology, our institutions, and ourselves; what will surely be unintelligible greetings in many languages; a sound essay on the evolution of our planet; and an hour and a half of the world's greatest music. But the hypothetical aliens are bound to be very different from us—independently evolved on another world. Are we really sure they could understand our message? Every time I feel these concerns stirring, though, I reassure myself: Whatever the incomprehensibilities of the Voyager record, any extraterrestrial that finds it will have another standard by which to judge us. Each Voyager is itself a message. In its exploratory intent, in the lofty ambition of its objectives, and in the brilliance of its design and performance, it speaks eloquently for us.

This Year, Over 60,000 Gardeners Will Switch To America's Tiller

. . . and enjoy gardening as never before!

Why waste money on a big tiller if you only have a backyard garden? Mantis, the *20-lb. wonder tiller,* is changing the way Americans garden!

The Gardener's Champion

So *powerful* it cuts through hard-packed soils and tough vegetation the way a chain saw cuts through wood . . . *so strong* that we *guarantee the tines forever* — and give you a *Lifetime Replacement Agreement on the engine!*

Best of all, you'll love its price. *Under $300!* If you charge it on any major credit card, it's only *$24 a month,* plus a little interest.

But Don't Take Our Word For It

We want you to test Mantis in your garden for a full 3 weeks (and our trial doesn't start until you start gardening)! Now, who else will let you do that?

★**Cultivating (weeding).** By simply reversing the tilling tines, Mantis will work in the top 2″ to 3″ of the soil.

★**Planting, furrowing, trenching.** Special tines let you dig furrows for transplants, seeds, etc.

★**Lawn care.** De-Thatcher pulls up choking thatch, Aerator cuts slits in the sod to give you rich, lush green carpet.

Mantis

Mantis Manufacturing Co.
1458 County Line Rd., Dept. 3016
Huntingdon Valley, PA 19006

☐ **Yes. Please send more information on the Mantis Tiller/Cultivator and the 3-WEEK TRIAL.**

Name ____________
Address ____________
City ____________
State ____________ Zip ____________

©1986 MMC

Send TODAY For
FREE LITERATURE!

Garden Way's SUPER TOMAHAWK Chipper/Shredder!

- Turn "Ugly" Piles Of ...BRUSH ...LEAVES ...GARDEN LEFTOVERS... & MORE Into Valuable, FREE Mulch, Fertilizer, Compost, More!
- Create A More Attractive Yard... Build A Healthier, More Productive Garden!
- 10 TIMES FASTER Than Electric Shredders!

Mail This Coupon To
Garden Way Mfg. Co.,
Dept. A374
102nd St. & 9th Ave.
Troy, N.Y. 12180

Limited-Time Offer
Now Available
7.5% FINANCING PLUS, SPECIAL SAVINGS!
Send For FREE Details!

☐ **YES!** Please send me complete SUPER TOMAHAWK Chipper/Shredder Literature including prices, models and SPECIAL SAVINGS OFFER right away! A374
3 13

Name________________
Address ________________
City ________________
State ________ Zip ________

NOW DISCOUNTED! SCIENTIFIC CALC. CHRONOGRAPH

1 YEAR WARRANTY — 30 DAY TRIAL

By CASIO

Silver-tone Model

25 SCIENTIFIC FUNCTIONS & MORE!

FEATURING —

- Panel access to 25 scientific functions
- Add, divide, subtract, & multiply
- Regular time, 12/24 time
- Electronic auto-calendar
- Daily alarm, hourly alarm
- 24-hour - 1/100 second stopwatch
- Long-life battery
- Night light
- Accuracy to 1/2 sec. per day

And it's only $29.95 SALE ~~$39.95~~ Polysulfone

We've made a special purchase of a large quantity of these quality scientific chronographs and we're passing the savings on to you. All these scientific calculating abilities go on your wrist: sin, cos, tan, sin^{-1}, cos^{-1}, tan^{-1}, log, 1n, 10^x, e^x, x^y, x^{2y}, $\sqrt{\ }$, x^2, 1/x, 0′ ″, 0′ ″, EXP, +, −, ÷, π, ( ), DEG, RAD, GRA and %. You also get instant metric conversion capabilities along with stopwatch, 12/24 time, calendar, daily alarm and night light. Black polysulfone **CFX-20** is only **$29.95** and silvertone **CFX-200** is **$39.95.** Order now and be delighted.

1 YEAR WARRANTY — 30-DAY MONEY-BACK GUARANTEE

Card Holders Call Toll-Free **800-437-4385**

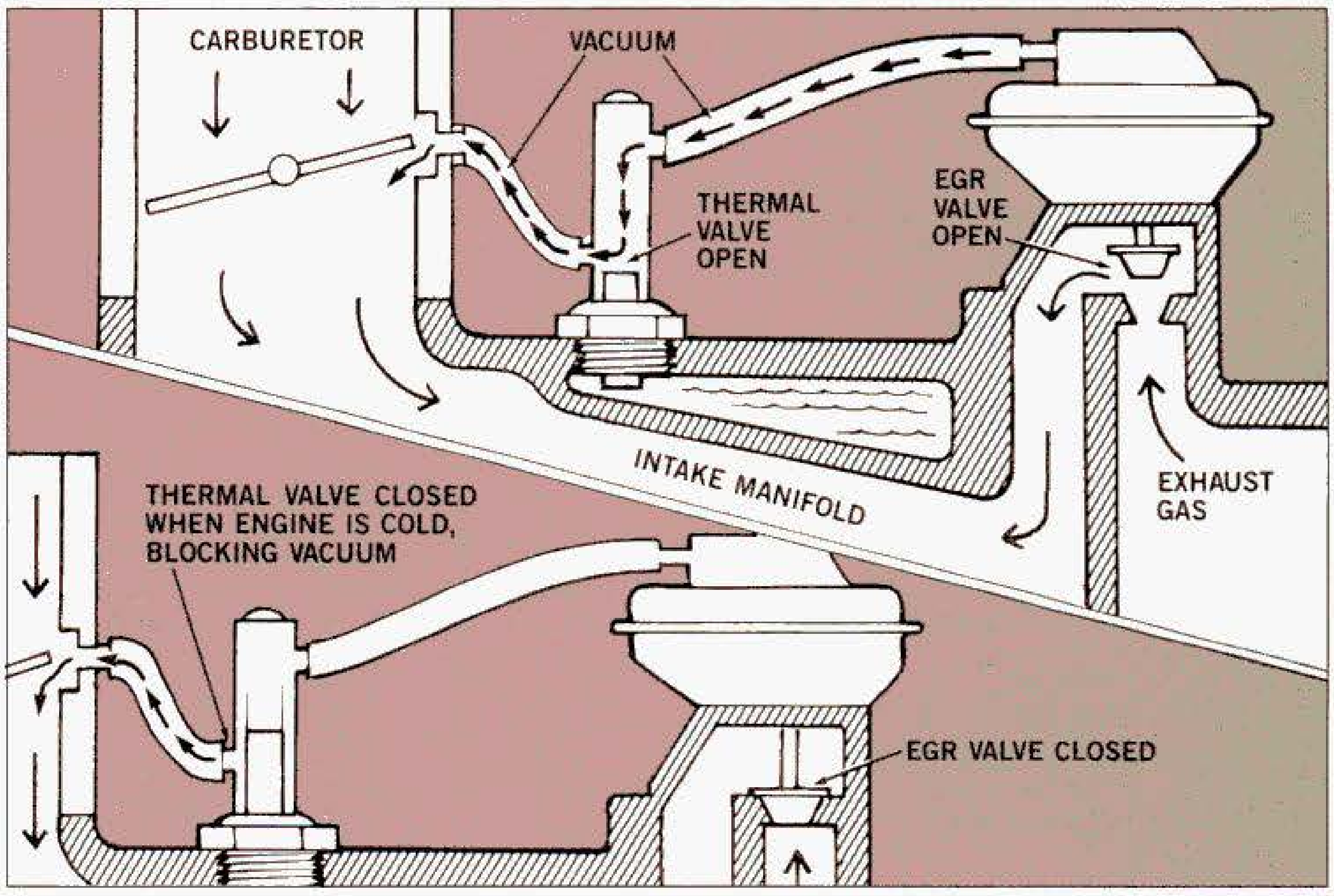
On The Run
107 Roberts St., Dept. PS-10
P.O. Box 67, Fargo, ND 58107
Telephone (701) 232-9400

Add $3.00 shipping or $5.00 air delivery for each watch. Write for a free one-year catalog subscription.

Taking Care of Your Car

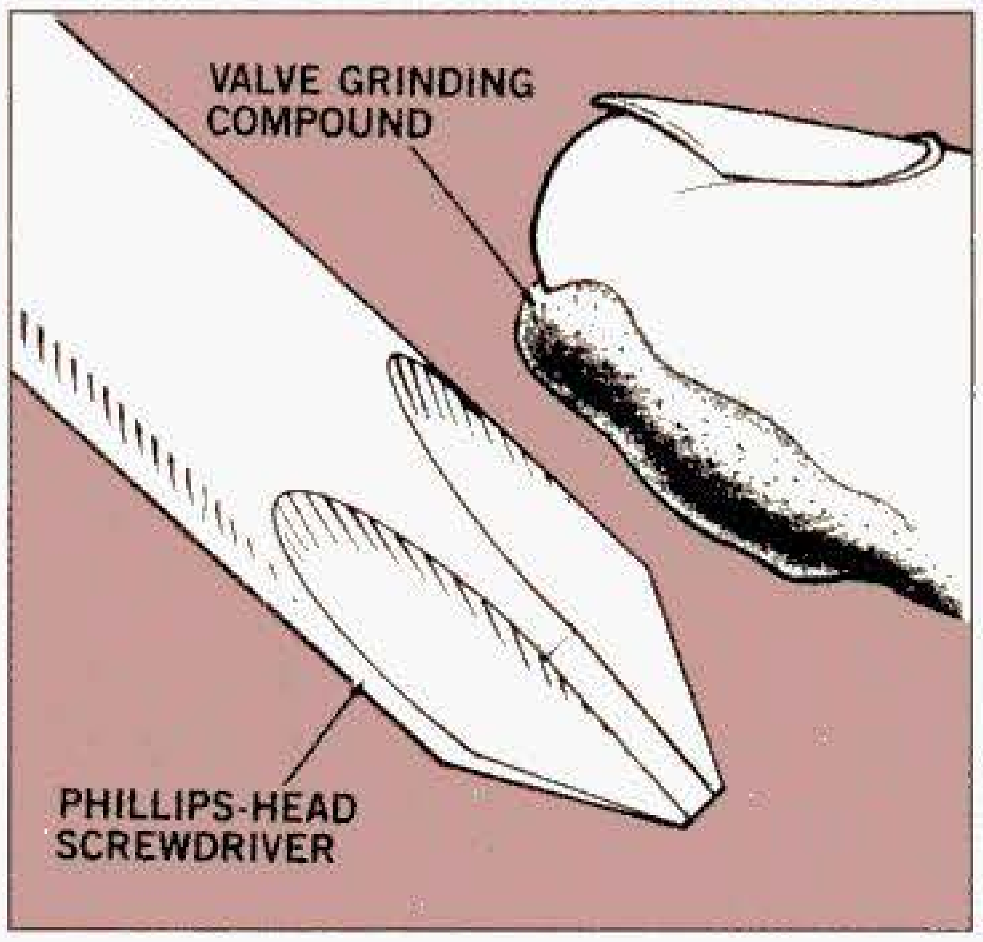
By STEVE MERCALDO

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



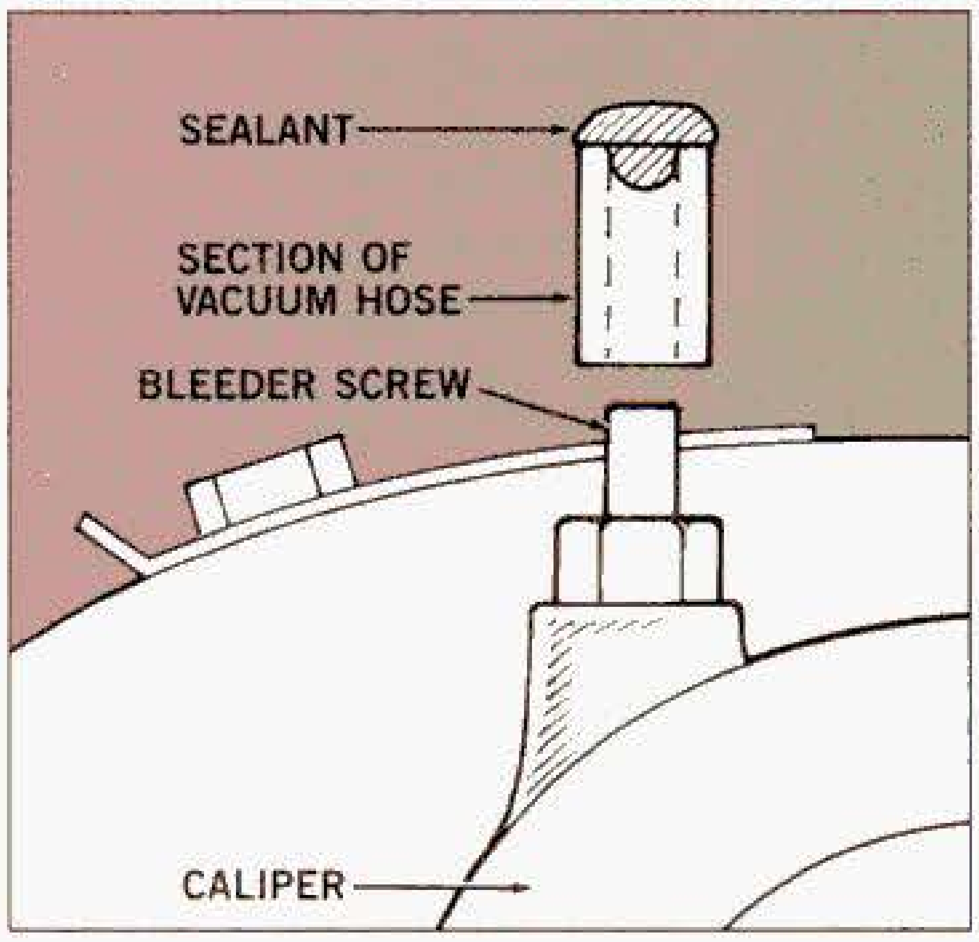
Checking for stumble or ping

The exhaust-gas recirculation (EGR) valve dilutes the air-fuel mixture with inert exhaust gas to lower combustion temperature, reducing ping. On many cars, it is controlled by a thermal valve. If the valve fails while open, dilution of the mixture can cause the engine to stumble when cold. If it fails closed, lack of recirculation can cause pinging. Locate the thermal valve on the under-hood vacuum-line diaphragm, and check it with a hand vacuum pump. On most cars, with the engine cold, it should block vacuum. When the engine is warm, it should allow vacuum to reach the EGR valve.



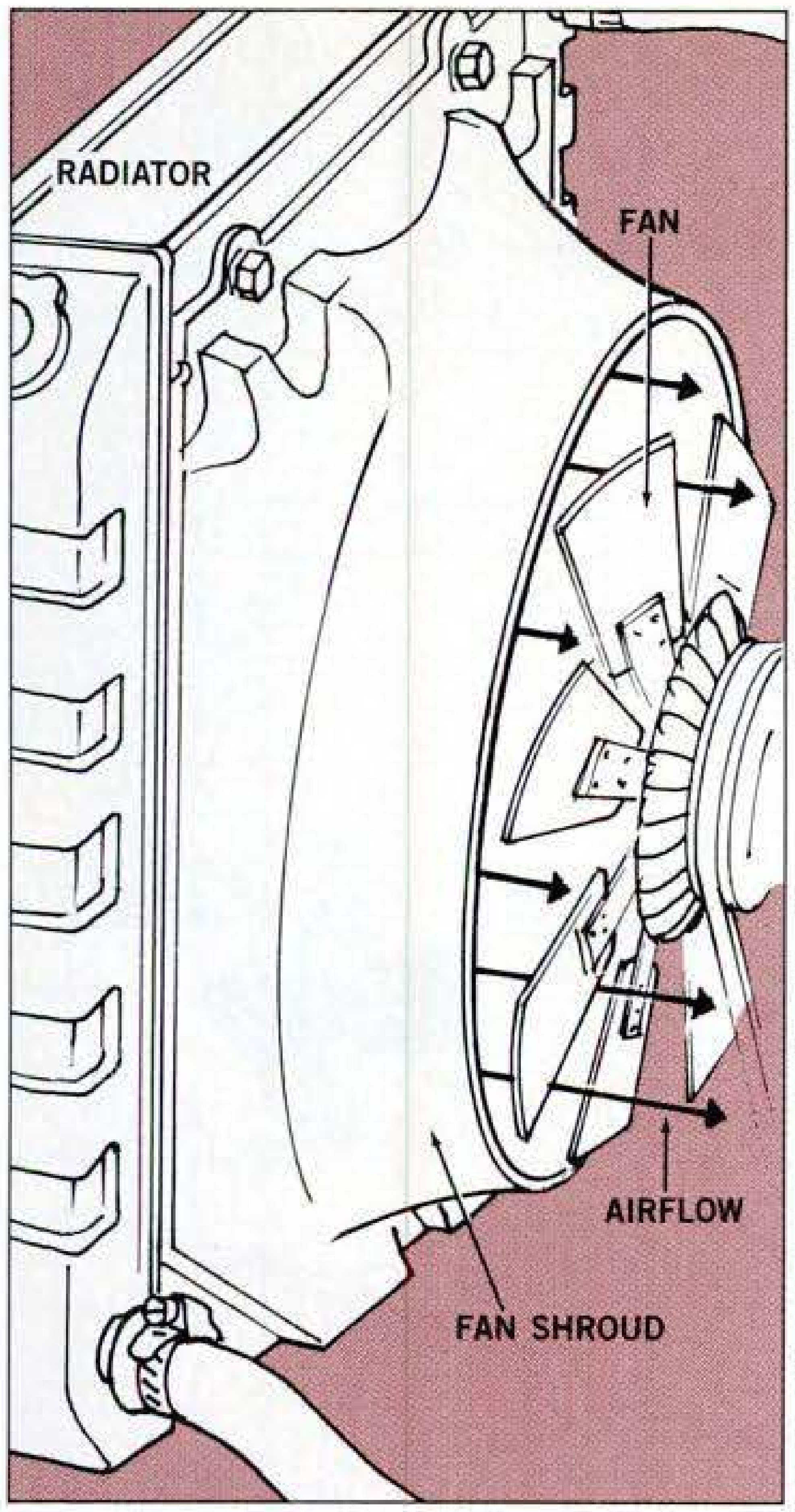
Slip grip

Trying to remove a damaged or corroded Phillips-head screw can be difficult. Often the driver slips out of the shallow slots in the screw, damaging them further. For some extra grip on a reluctant Phillips-head fastener, apply valve grinding compound to the driver tip. This should provide the bite to get things moving.



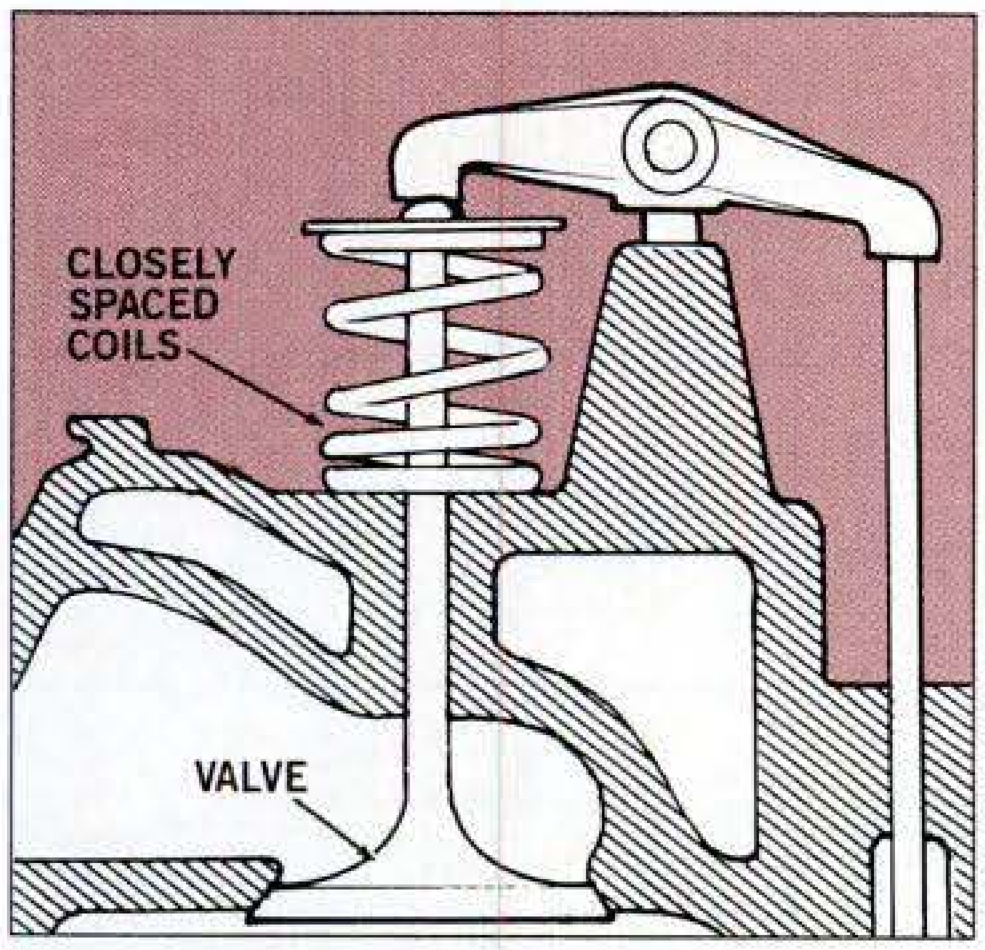
Bleeder-screw cover

The rubber caps that keep corrosion out of the brake-system bleeder screws are easily lost. Left uncovered, the hollow screws clog and often sheer off when an attempt is made to loosen them. To provide weather and dirt protection, make a cap from a piece of vacuum hose, using a bit of silicone sealant to close the open end.



Shrouded mystery

Mysterious overheating may be caused by a missing or heavily damaged radiator-fan shroud. The shroud encircles the blades, making the fan more efficient at drawing air through the radiator. Fan-shroud problems often are noticeable only during prolonged idling or in slow-moving traffic.



Valve-spring tip

When an engine's cylinder head is being assembled, carefully examine the valve springs to determine whether they are progressively wound. (If they are, the spring coils are closer together on one end). Progressive valve springs should always be installed with the end having closely spaced coils nearer the cylinder head.

Authorized COMB Liquidator

BEL MICRO-EYE RADAR DETECTOR

Compuheterodyne Micro-Eye SELECTRA II

- **Long Range.** Alerts You to Radar 1-2 Miles Ahead or Behind.
- **Reliable.** Detects "K" and "X" Radar, Plus Pulse Hand Guns.
- **Compact.** Just 3⅛" x 5½", it Slips Into Your Pocket to Prevent Theft.
- **Selective.** Microprocessor Circuitry Provides Early Detection.
- **3 Alarms.** Single Beep, Followed by Clicking Sounds. LEDs Flash.
- **Twin Switches.** On/Off. City/Highway.
- **Easy Setup.** Clips to Sun Visor. DC Power Cord Plugs Into Vehicle's 12V Cigarette Lighter.

1-Year Limited Factory Warranty.

Mfr. List $239.95

Liquidation Priced At $88

Item H-1508-3436-003 S/H: $3.75 ea.

Both FRONT and REAR detection!
BEL
MICRO EYE Selectra
BEL
Model 841

VOID WHERE PROHIBITED BY LAW.

4000 WATT POWER GENERATORS

Heavy-Duty! Commercial! Factory New!

Because we made special arrangements to liquidate manufacturer's overruns, you can save on these factory new units priced **BELOW dealer cost!** Order TODAY!

- Unique Design for Best Alignment.
- Heavy Machined, Rolled Steel (Not Laminated Steel) for Long Life.
- Meet IEEE and NEMA Standards.
- 8-hp. 4-Cycle, Tecumseh Engine. No Mixing Gas or Oil.
- Long Life Cast Iron Cylinder Sleeves.
- Dependable All Copper Windings.
- Outlets: Two 115V AC, 15 Amp; One 230V AC, 15 Amp.
- **One-Year Limited Factory Warranty on Parts and Labor.**

Other Models Available. Phone Us Toll-Free.

U.S. Made.
U.S. Quality.

RECOIL START, GASOLINE	**ELEC. START, GASOLINE**	**ELEC. START, MULTI-FUEL**
Size: 18" H x 25" W x 17½"	Size: 18" H x 25" W x 17½"	Size: 18" H x 26" W x 17½"
D. Ship Weight: 140 lbs.	D. Ship Weight: 140 lbs.	D. Ship Weight: 143 lbs.
Compare At: $1000.00	**Compare At: $1100.00**	**Compare At: $1195.00**
Liquidation Priced At .. $429	**Liquidation Priced At .. $488**	**Liquidation Priced At .. $629**
Item H-1508-1043-355	**Item H-1508-1043-371**	**Item H-1508-1043-348**
Shipped Freight Collect	**Shipped Freight Collect**	**Shipped Freight Collect**

Toll-Free: 1-800-328-0609

Credit card customers can order by phone, 24 hours a day, 7 days a week. VISA MasterCard AMERICAN EXPRESS

SEND TO: **Item H-1508**
C.O.M.B. Direct Marketing Corp.
1405 Xenium Lane No./Minneapolis, MN 55441-4494

Send the items indicated below. (Minnesota residents add 6% sales tax. Sorry, no C.O.D. orders.)

Send____**Bel Radar Dectector(s)** Item H-1508-3436-003 at $88 each, plus $3.75 each for shipping, handling.

Send____**Recoil Start Generator(s)** Item H-1508-1043-355 at $429 each, shipped freight collect.

Send____**Electric Start Generator(s)** Item H-1508-1043-371 at $488 each, shipped freight collect.

Send____**Electric Start/Multi-Fuel Generator(s)** Item H-1508-1043-348 at $629 each, shipped freight collect.

Charge: ☐ VISA® ☐ MasterCard® ☐ American Express®

Acct. No.______________ Exp.___/___

PLEASE PRINT CLEARLY

Name______________

Address______________

City______________

State______________ ZIP______________

Phone (____)______________

Sign Here______________

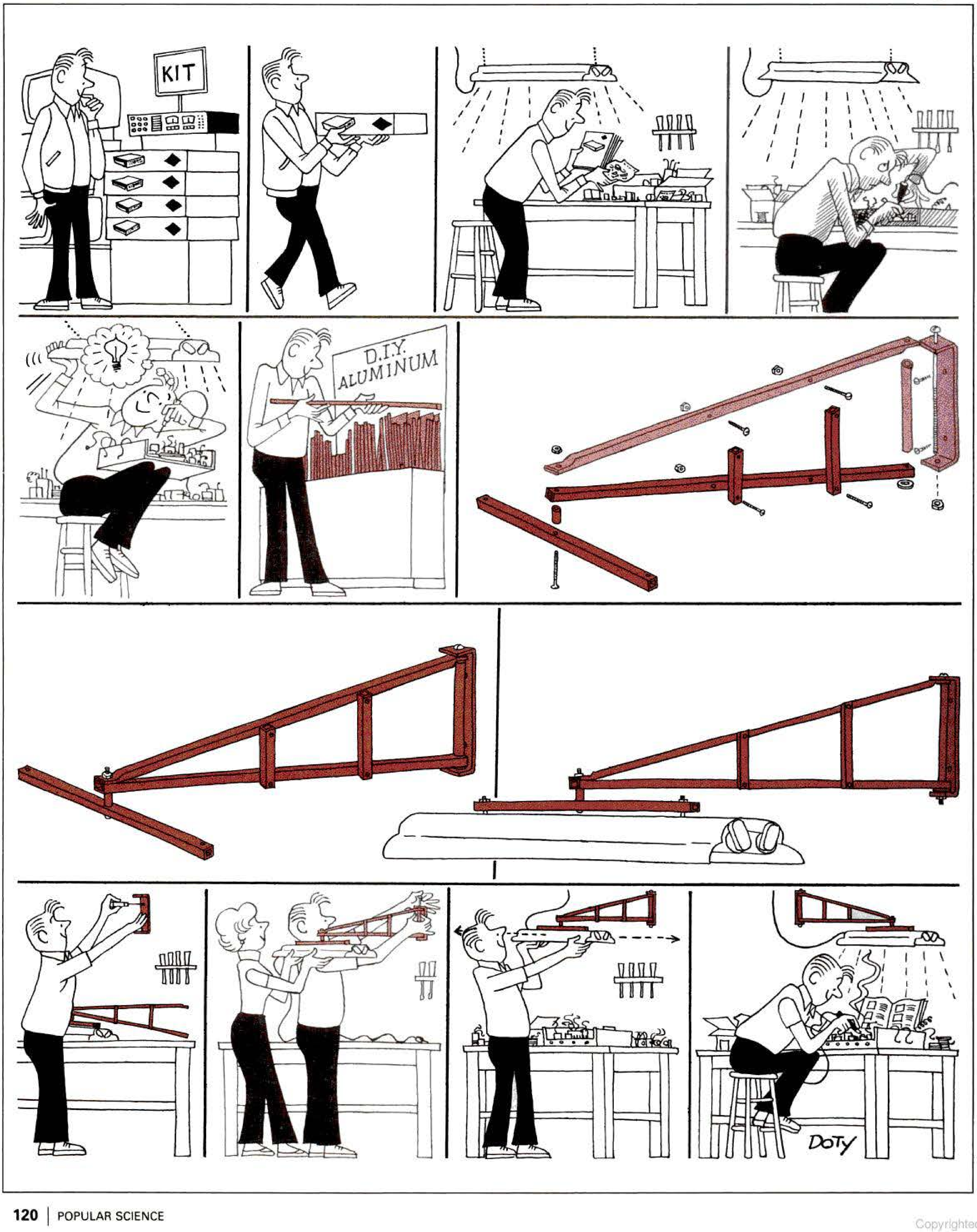
Sales outside the 48 contiguous states are subject to special conditions. Please call or write to inquire.

COMB COMB COMB COMB COMB

Wordless Workshop

By ROY DOTY

$50 to Larry Baker of Muskegon, Mich., for this idea. Send yours (with Social Security No.) to Wordless, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged.



New Technological Breakthrough

HOW TO UNLEASH YOUR MIND-POWER TO ACHIEVE ALL YOUR GOALS FASTER.

Subliminal Stimulation™ is Today's Answer. It's NEW!

You've read in science and technical magazines about the great success of **subliminal stimulation™** techniques. Now, thanks to recent breakthroughs by leading scientists, you can use these same innovative techniques to step up your accomplishments and unleash your mind-power!

For example, maybe you want to sharpen your memory. This is really important when you're working on your car or building things around the house. There are so many steps to remember. Or maybe you need to lose weight, stop worrying or hone your mental skills. Just think how great it would be to grab money-making opportunities by drawing on your mental capabilities to the maximum extent. Or maybe you want to lessen stress, have greater self-esteem and razor-sharp decisiveness. These are just a few of the accomplishments now easily within your grasp.

The subconscious or "inner mind" is a mysterious thing. Scientists are finding out more about it every year. It's not like your conscious mind. Instead it soaks up impressions. You'll be amazed how fast the "success-mechanism" already within you will put you ahead of the game in life.

Subliminal Techniques are men's problem solvers for the 1980's and beyond.

Subliminal stimulation is a remarkable scientific discovery. For example, to reduce shoplifting. Department store managers nationwide are finding that a "hidden" message in the public-address music cuts pilferage substantially. This message repeats over and over such tested phrases as "I am honest. I don't steal."

Talk about effective! Customers aren't even aware of it. Yet inventory statistics prove there's a big decrease in shoplifting. In fact, in some cases by as much as 67 percent.

Your subconscious is powerful. Put it to work to bring you success fast. Thousands of men already are.

Until recently, scientists were stopped dead in their tracks in figuring out how to harness the powers of the inner mind. For years we've known it could be tapped. But the big question was: "How can the average man put its huge power to work?"

Through constant testing a breakthrough finally came. The credit goes to some of the top scientists in the country. Their hard-hitting efforts now enable you to push ahead, no matter your goals, and enjoy tremendous success fast.

The answer is Subliminal Stimulation Tapes. Each brings you two different kinds of assistance.

Put a tape on your regular cassette player—then get ready for a surprise. On one side is *subliminal stimulation™*. Here's how it works: You hear waves breaking on a rugged shoreline. But your subconscious hears more. There are subliminally embedded messages at work—literally hundreds. Now you'll have a hard time hearing them consciously. But your subconscious will hear them as clear as a bell. Scientists have found the subconscious then goes into gear at once.

Listen while you work around the house or while relaxing, watching TV or even while jogging, working out, or driving your car. The sounds of the waves make a smooth background while alone or with your family or friends.

Subliminal stimulation is so effective it's being featured in scientific and technical journals. Just wait until you try it! It's a totally new, yet natural, experience. You'll feel at home with it fast. A to-the-point briefing on each tape gives you the exact wording of the subliminal messages coming up. It's really fascinating and worry-free.

Now, on the other side you'll hear a voice. This is called the *natural response™* program. You'll hear "commands to your subconscious." Think what it will mean to actually be in control of your subconscious. At last, you'll be showing it who's boss!

Be a part of the cutting edge of today's world of science.

Here's your opportunity to discover a sure-fire way to achieve all your goals—no matter what they are—in record-breaking time. You'll feel more alive, more virile and see success after success come your way. Taking advantage of new scientific discoveries puts you one step ahead of the crowd.

Professionals nationwide are finding Subliminal Stimulation Tapes to be one of the biggest scientific breakthroughs of the 80's. Each side actually wakes up your inner mind. Result? You'll see yourself becoming sharper, more "in charge" than ever. You'll get more done faster. And the great part is, each side is so relaxing you'll want to listen time and time again.

Don't let your subconscious lay idle. Put it to work. Scientific-minded men everywhere are—with outstanding success.

Order today. Read about this Special Money-Saving Offer:

Each **Subliminal Stimulation™ Cassette** sells for $14.95. But during this **Special Introductory Offer** to *Popular Science* readers, the price is only $9.95. You save $5.00 on each and every selection.

But here's still more good news. You get one FREE for every three you order! Just fill out the No-Risk *Express* Order Form and rush it back today, along with your check or money order. Or use your Visa or MasterCard. You're protected by our **FULL MONEY-BACK GUARANTEE**: We call it our *"triple-length"* guarantee because it's good for 90 days, not 30. If you're not elated with the results the tapes bring, return them for a full, prompt refund—including the $2 shipping and handling.

©1985 Advanced Learning Systems, Inc.

Prompt shipment guaranteed. Mail your order today! Credit card users, order

TOLL-FREE
1-800-624-9000
Extension 232

MasterCard VISA

ADVANCED LEARNING SYSTEMS, INC.—Corporate Offices:
7131 Owensmouth Ave., Canoga Park, CA 91303

"TRIPLE-LENGTH" 90-DAY FULL MONEY-BACK GUARANTEE
plus Lifetime Warranty Against Defects

NO-RISK *EXPRESS* ORDER FORM

Check your choices and mail today:

- ☐A1106 **UNLIMITED MENTAL POWER**
- ☐A1102 **MEMORY IMPROVEMENT**
- ☐A1202 **WEIGHT LOSS**
- ☐A1303 **DYNAMIC SELF-CONFIDENCE: Overcoming Shyness**
- ☐A1104 **PINPOINT CONCENTRATION**
- ☐A1602 **RUNNING FOR FITNESS AND FUN**
- ☐A1316 **SELF-ESTEEM: Feel Good About Yourself!**
- ☐A1301 **HIGH-ENERGY & ENTHUSIASM**
- ☐A1507 **PROSPERITY: Financial Success**
- ☐A1304 **DECISIVENESS: Stop Procrastinating!**
- ☐A1502 **SUPER SALES POWER**
- ☐A1509 **TIME MANAGEMENT: Get More Done Every Day**
- ☐A1315 **THINK POSITIVE!**
- ☐A1317 **SELF-ASSERTIVENESS**
- ☐A1214 **ENJOYING EXERCISE: Have Fun Getting in Shape**
- ☐A1310 **STRESS RELIEF**
- ☐A1105 **BETTER STUDY AND EXAMS**
- ☐A1309 **MAGNETIC PERSONALITY**
- ☐A1318 **INCREASE PERSONAL POWER Gain Influence and Respect**
- ☐A1101 **READ FASTER**
- ☐A1508 **SUCCESS NOW! Get Ahead Fast**
- ☐A1302 **PROBLEM SOLVING Creative Dreaming**
- ☐A1306 **FREE YOURSELF FROM WORRY**
- ☐A1206 **RESTFUL SLEEP: No More Insomnia**
- ☐A1320 **WINNING SELF IMAGE**

- ☐A9001 Sanyo Slimline Cassette Recorder $39.95
- ☐A9002 Sanyo Sportster Mini-Stereo Cassette Player w/Headphones $29.95

Special Introductory Offer: Regularly $14.95 each. Now if you hurry, **only $9.95 each.**

FREE BONUS **CHOOSE ONE FREE FOR EVERY THREE YOU ORDER.**

SUBTOTAL________

California residents add 6½% sales tax________

POSTAGE & HANDLING (any size order) 2.00

☐Cash ☐Check ☐MO **TOTAL**________

☐VISA ☐MasterCard Exp. Date________

Card Number ________

NAME ________

ADDRESS ________

CITY ________

STATE ________ ZIP ________

Mail to:
ADVANCED LEARNING SYSTEMS, INC.
7131 Owensmouth Ave., Dept. PS6A
Canoga Park, CA 91303

Shoppers' Showcase

A selection of products and services for Popular Science readers available direct by mail. Enjoy the fun and convenience of mail ordering shopping. Please order directly from the advertiser. For advertising rates for this section, write Advertising Sales, Popular Science, 380 Madison Avenue, New York, N.Y. 10017

Only one person can design exactly the home you want.

Nobody knows what *you* want better than you do. And the design flexibility of a Lindal lets you create it with the walls, windows, and rooms exactly where you want them.

To get you started, we provide you with more than 90 different plans in our Planbooks. And if you don't see exactly the one you want, we have plenty of ideas to help you create one more. Yours.

For more information, send $7. You'll get two Lindal idea books filled with floorplans and color photos. Write or call toll free and use MasterCard or VISA.

1-800-426-0536

LINDAL CEDAR HOMES

P.O. Box 24426, Dept.C96, Seattle, WA 98124 (206) 725-0900 • 10880 Dyke Road, Dept.C96, Surrey, B.C. Canada, V3V-7P4

Wood-Mizer®

Three Models Available

Portable Bandsaw Mills

- One Man Operation
- Safe - Precise
- Capacities to 32" Dia. x 33' Long
- More Lumber Per Log

Prices from $3,995.00

Buy direct from the world's largest manufacturer of Portable Bandsaw Mills at any of 3 Factory Sales Locations

For catalogs send $1.00 to:
Wood-Mizer® Dept E23 8180 W. 10th St. Indpls, IN 46224 (317) 271-1542

WHAT'S HE DOING!

Making a Concrete Flower Pot! . . . and SO CAN YOU!

Make and sell your own Ornamental Concrete Items. Rush $5.00 for Book about Aluminum Molds with prices and production trade secrets direct from world's largest mold manufacturer. Over 350 designs to select from.

Send $5.00 Today To ➤

CONCRETE MACHINERY COMPANY
P. O. BOX 899 - HICKORY, N. C. 28601

HERNIA

BRIEFS — **Medicare Pays 80%**

BRAND NEW - No truss, belts or hard pads. Wash and wear. 88% cotton. Wear 24 hrs. **Looks like regular underbrief.** Operation not necessary. Money-back guar. Write or call for FREE brochure in plain wrapper.

Toll FREE 1-800-325-0007 (24 hrs./7 days)
(Fla. call collect 305-235-7736)
H.P.H. CORP. (Ortho/Med. Mfg.)Dept. H86-D
1939-C Del Prado Blvd., Cape Coral Fl. 33904

MAGNIFYING GLASSES

Make Small Type
LOOK BIG!

A Blessing For Folks Over 40

Easily read your phone book, Bible, ads or labels! 30 day home trial. Not for astigmatism or eye disease. U.S. made impact resistant lenses. State age/sex. Only $9.98 + 75¢ handling.

Precision Optical, Dept. 69-E Rochelle, ILL. 61068

A SINGER'S DREAM!

REMOVES VOCALS FROM RECORDS!

Now You can sing with the world's best bands! The Thompson Vocal Eliminator can remove most or virtually all of a lead vocal from a standard stereo record and leave most of the background untouched! Record with your voice or perform live with the backgrounds. Used in Professional Performance yet connects easily to a home component stereo system. Not an equalizer! We can prove it works over the phone. Write or call for a Free Brochure and Demo Record.

LT Sound, Dept. PS-3, P.O. Box 338,
Stone Mountain, GA 30086 (404) 493-1258
24 HOUR PHONE DEMO LINE: (404) 493-6879

MAGNATRAC®

$3995

COMPLETE KIT... less loader

Assemble this unique tractor kit. Thousands used for landscaping, gardening, excavating. Work for others for CASH!

CATALOG of "factory-made" Magnatrac Kits...$ 1.00
PLANS to build a Magnatrac from local parts.....$ 7.00

STRUCK-KIT Dept: PS106 CEDARBURG, WI 53012

PARK • A • PORT

10 X 20 Ft. Covers
For Cars • Trucks • Boats

Steel Frame / 1 Hr. Assembly
Heavy Duty Poly-Tarp Cover

Send $1 for brochure & fabric sample to:
AMERICAT • Dept. PS • N.3018 Nevada • Spokane, WA 99207
☎ (509) 484-9223

BE A LOCKSMITH

EARN WHILE YOU LEARN—SEND FOR FREE BOOK

Big opportunities. Big profits. Earn quickly. Full or part time. Learn at home, it's easy. Do real jobs while you learn. **All Tools—Materials Supplied.** State of NJ Approved. Send name and address for FREE book. No salesman will call.

LOCKSMITHING INSTITUTE
Div. Commercial Technical Institute
1500 Cardinal Drive, Little Falls, N.J. 07424 Dept. 311-106

CTI COMMERCIAL TECHNICAL INSTITUTE

Complete Satellite Listings

Sample Copy $1, or call toll free
800-358-9997 in U.S. **800-556-8787** in Ca.
707-725-2476 all others

satellite TV week

P.O. BOX 308H0301 FORTUNA, CA 95540

HARD-TO-FIND SCIENCE BUYS NOW ON SALE!

America's Largest Mail-Order Market Place of Unusual and Fascinating Values of Science, Weather, Health, Electronics, Magnets, Tools, Science Kits, Magnifiers, Microscopes, Telescopes and More. For Hobbyists, Gadgeteers, Students and Educators.

Build Giant Dinosaurs.

FT.
ALL

yrannosaurus

Brontosaurus 11 FT. LONG

A great project for children to set up these huge, enormous, incredible nosaurs. The "bones" are made of strong, heavy duty (500 ound test) double wall corrugated board. Each piece is num ered for placement. **Choice of: Tyrannosaurus, 6** ft. **tall 331,221 or Brontosaurus, 11 ft. long BB31,222 Ea.** $49.95
dd $4.50 for postage and handling

uild Your Own Clock Of Paper, Really Keeps Accurate Time.

ut up this heavy stock 40 page book, upply a little glue, three paper clips, nail, tring and perseverance and you have a orking clock which keeps accurate time nd has a real "tick-tock" pendulum novement. You rewind and regulate it. **BB9687 $7.95**
dd $2.50 for postage and handling

wo-In-One 50X Microscope Becomes 10X Sportsman's Telescope.

wo precision quality instruments in ne...with fully coated optics. As a micro cope you get a powerful 50X magnifica on for close inspection of fine detail and amining tiny objects. Study insects, inerals, stamps, etc. Simply tilt to focus. ighly polished metal reflector reflects aximum light on the object. Extend the be and it becomes a 10X telescope... erfect for hunters, bird watchers, racing d sports fans. **BB36,118 $14.95**
dd $2.50 for postage and handling

MICROSCOPE

TELESCOPE

uild Your Own 2000° Solar Furnace With This resnel Lens And Harness The Sun's Rays!

You'll be able to use this precision lens as a solar cooker for heating food, as a kiln for pottery – and even to melt metal or for other solar experiments. Lens has an 8½" f.l., 50 lines per inch, measures 10½x10½" 1/16" thick. Unmounted lens comes with 16 page book, "Fun With Fresnel Lens." Instructions included on how to build the 360° stand and frame shown. **BB70,533 $15.95**
Add $2.50 for postage and handling

atch A Society Of Ants Dig Tunnels, Build ridges And Move Mountains Before Your Eyes!

nts are the world's finest engineers...and eing them plan and construct their intri te highways and subways is fascinating. rough the large plastic case of the cage 0x15") of this giant ant farm, u'll see the ant soldiers guard g the roads, the laborers carry g their load and the supply rps storing away food for the hole colony. **BB70,295 $17.95**
d $2.50 postage and handling

Easy To Identify Stars In The Sky With Rotating Star/Planet Locator.

Handy chart shows location of 500 stars and their relationship and location at any time. Plotted by astronomer George Lovi. With 16 page booklet of instructions and simplified celestial drawings. 8½"x8½" chart. **BB9227 $2.50**
Add $1.00 for postage and handling

adiometer...A Space Age Sphere.

s fascinating to watch the delicate vanes thin this 5" precision-made sphere spin ster and faster illustrating the basic prin ple of solar heating. When light strikes the nes it transfers heat, and the vanes begin move. Works from direct sunlight or ar icial light. An attractive "conversation ece" for your home. *Add $2.50 postage d handling* **Reg. $6.95 BB60,082 $4.95**

Stars That Glow In The Dark Turn Your Bedroom Ceiling Into The Night Sky.

Assortment of 250 luminous stars that glow in the dark on ceiling or wall. Light a child's room with the beauty of glowing stars and have fun h astronomy. Easy to apply decals glow after exposure to ht. Comes with star chart and instructions to recreate the Dipper, Milky Way and the heavens. **BB9521 $3.95**
d $2.50 postage and handling

Go Fishing With This Mighty Magnet.

Lift up to 200 lbs. Fun to use around docks and bridges. A 'must' for a boat, it helps retrieve metal objects that fall overboard. You'll be amazed at what you pull up. Wt. 2 lbs., measures 4x3¾x3¼" Made with a Poly-Vinyl Chloride coating to resist corrosion and chipping. **BB71,135 $26.95**
Add $2.50 for postage and handling

u'd Almost Think Our Whistle Was The Siren ail Heard From A Police Car!

s **superb** whistle duces **a** loud, en-type wizzing se from a delicately anced mechanism crafted by **skilled** British whistle makers. 7" extended bell piece gives **extra** amplification. Great at rting **events, for** bike riders – **anyone on the move.**
$2.50 for postage and handling **BB35,988 $24.95**

Build A Working Replica Of The Steam Engine Popular In The 1800's.

WHEEEEE

Steam engines, the workhorse of the 19th century, powered machinery, farm equipment, the Stanley Steamer and trains that crossed the country. The simplest was the single stroke piston engine – power occurring when the piston moved in one direction. Kit has everything needed to recreate a working replica – from crank shafts, cylinder, piston, boiler parts, nuts, bolts, gaskets, etc. including fully illus. instructions. **BB72.202 $59.95**
Add $2.50 for postage and handling

Mini-Vac, The Powerful Micro Cleaning System For Your Fine, Expensive Equipment.

Dust and dirt is the enemy of your camera, lenses, stereo, computer, typewriter and office machines. This powerful micro cleaner removes minute dust particles from hidden areas. Comes with 2 wands for getting into hard-to-reach corners, cloth bag and 2 soft brushes. Powered by a single 9V battery (not incl.).
Add $2.50 for postage and handling **BB33,806 $29.95**

Nutty Magnet Balls Jump, Wiggle... And Defy The Law Of Gravity.

There's no end to the imaginative things you can do with these magnetized "marbles"! They roll in crazy directions, making for a wild game of marbles! Great entertainment at parties; a fun way to teach children about magnetism. Package of 4 balls. **BB60,508 $2.95**
Add $1.00 for postage and handling

Powerful Tire Inflator Pumps Instant Air – When And Where You Need It.

A must for every safety-minded motorist. Deluxe Mini Air Compressor delivers a full 150 psi of air pressure – enough to inflate your auto tire. Simple to operate. The 10 ft. cord plugs into your car's cigarette lighter. Set the desired air pressure and snap the air hose into your tire valve. The inflator will automatically stop when the preset air pressure is reached. And, you save on costly service calls, gas mileage is increased and tire wear is reduced with properly inflated tires. Many other uses too – inflates bicycle tires, sporting equipment, inflatable boats and air mattresses. ***Reg. $27.95***
Add $2.50 for postage and handling **BB34,071 $24.95**

Motors By The Bag For Hobbyists, Modelmakers.

Our inexpensive motors can make wheels go 'round, propellers turn. Unlimited applications.

Have fun by adding motion to your science fair projects, demonstrations and experiments with this special buy of 20, 1" motors with ⅜" long shafts and 2 wire leads. **20, 1" motors BB1304 $9.95**
Add $2.50 for postage and handling

Flying Bird From France.

This marvelous bird will bring hours of fun. Has a 16" wingspan and can fly up to 40 ft. high and a distance of 150 ft. Power is supplied by twist motion of rubber band. Adjust for up, down, swooping flight. Made of strong mylar, durable polypropylene with rubber beak. **BB42,720 $7.95**
Add $2.50 for postage and handling

Duplicate Most Any Object In Detail With Multi-Use Latex Rubber Mold Compound.

Make replicas of most any object, duplicating the finest detail – coins, medallions, charms, figurines and more. Form flexible, durable molds. Use with plaster or expandable foams. **Quart Size. BB42,446 $15.95**
Add $2.50 for postage and handling

Worlds Smallest Fluorescent Blacklight Fits In Shirt Pocket.

This mini blacklight will detect check forgeries by illuminating bleaches – shows where fluorescent inks are used in art forgeries – ideal for rock and mineral collectors – perfect for night hunters of bugs and butterflies. 2¼ x ¾ x 7," weighs only 3½ oz. Requires 4 "AA" batteries (not incl.). 4 watts. **BB35,485 $29.95**
Add $2.50 for postage and handling

10 Foot Solar Dirigibles Fly In The Sky When Exposed To Sunlight.

SOLAR SHUTTLE

These 10x2 ft. mylar solar shuttle dirigibles will fly over houses and trees when exposed to the sun. Weighs only 2 ounces. **2 Solar Dirigibles BB35,889 $9.90**
Add $2.50 for postage and handling.

Aquarium Sea Magic That Does Not Take Up An Ocean Of Space.

Mini aquarium is a beautifully fashioned accent piece for home or office. Pump and airhose are cleverly concealed in the 6" square walnut finished base. Aquarium is 13" tall. Unbreakable circular acrylic tank. Includes 110V air pump, aquarium gravel and greenery. All you need to add are the fish. **BB35,971 $19.95**
Add $2.50 for postage and handling

Now You Can Enjoy Seeing Your Old Home Movies And Slides On Television.

It's easy and inexpensive to convert your home movies and slides to videotape. Just place your movie camera or slide projector and focus the image onto the mini-screen of the Tele-Cine converter. Aim your video camera into the lens, focus and start recording. 6½" x 5½" x 5." Screen is 3 x 3."
Add $2.50 for postage and handling **BB33, 528 $54.95**

Miniature Water Pump For Photo Darkrooms, Science Fairs, Water Displays.

This tiny pump can pump a pint per minute with a 12" high flow. Ideal for temperature control and circulation of darkroom chemicals, table fountains, model waterfalls, water filtration and more. Can be used in either direction and is self priming. Operates on 2 flashlight batteries (not incl.), runs up to 48 hours before battery change is required. 4" tube incl.
Add $2.50 for postage and handling. **BB50,345 $6.95**

Here's An Emergency Radio/Flashlight That Never Needs Batteries Or House Current.

When power failure strikes, and your batteries go dead, Dynamo Radio/Flashlight comes to the rescue. A unique, self-contained hand-crank generator provides sufficient power for hours of important AM/FM radio emergency information and a powerful bright light from its flashlight. A handy tagalong (without any emergency) at sporting events, camping or on vacation. *Add $2.50 for postage and handling.* **Reg. $39.95 BB35,420 $34.95**

Fun And Intriguing! You'll Play For Hours With These Colorful Magnetic Magic Marbles.

Build a mountain or odd geometric patterns with these fascinating, high impact plastic marbles. Each marble has both a negative and positive pole. A challenge to your imagination. Fun for youngsters, adults, too! 20 marbles per package.

BB34,968 (Package of 20) $3.49
BB27,898 (Package of 100) $14.95
Add $2.50 for postage and handling

Easy To Make Your Own Transparent Filters For Creative Photo Effects.

Vibrant colors for striking photographic effects. Heat resistant, 0.0005 to 0.10 thickness. A practical alternate to expensive 'store bought' filters. ***Available in sheets or booklet.*** Booklet of 44 sheets, each a different color.

Booklet: 1½x3¼" BB40,675 $5.95 5x8" BB60,403 $32.95
Available in 20x24" sheets (specify order # below) **$8.95**
BB82,010 Gold Amber; BB82,039 Dk. Urban Blue; BB82,031 Daylight Blue; BB82,034 Dk. Med. Blue; BB82,038 Lt. Med. Blue; BB82,000 Frost; BB82,040 Lt. Gr.; BB82,041 Med. Gr.; BB82,043 Yel. Green; BB82,004 Med. Lemon; BB82,012 Orange; BB82,029 Med. Purple; BB82,015 Med. Red.
Add $2.50 for postage and handling

Watch These Colorful Magic Rocks Grow Up To 4 Inches Within An Hour!

Colorful assortment of magic rocks will start to grow within seconds of planting in our 'growing solution.' They'll create a beautiful underwater rock formation display of rainbow colors in the clear plastic hexagonal aquarium. Complete with rocks, aquarium, cover and growing solution. **BB31,323 $9.95**
Add $2.50 for postage and handling

Nostalgic Miner's Lantern Will Brighten Your Night.

This true authentic reproduction of a coal miner's lantern of a bygone era will add charm to your study or den. Handcrafted in solid brass, the carbide lantern and 4" reflector produces an incredibly bright light. Starts easily with the strike of a flint, uses carbide fuel (comes with a 2 lb. fuel supply). Measures 5½" tall.
Add $2.50 for postage and handling **BB34,744 $24.95**

Great AM Radio Reception With Select-A-Tenna. Listen To Station WOR N.Y. When In Boston.

You'll now get excellent radio reception on all AM stations. Select-A-Tenna turns your AM radio into a powerful receiver. Used in Alaska to pull in stations from continental U.S. Employs mutually inductive coupling. Mini-jack and plug with 50 ft. of hook-up wire. 10¾" dia. **BB72,147 $39.95**
Add $2.50 for postage and handl'g.

The Human Skeleton.

Life-size skeleton model is a fascinating project. Each part is anatomically labeled. Sturdy cardboard paper construction. 8 hour assembly time. Fully posable, universal movement and extension/flexion. Can be used for classroom or science project. **BB35,966 $49.95**
Add $2.50 postage & handling

Follow The Flight Of The Seagull.

This graceful, artistic mobile seagull has 36½" wide wingspan and goes into elegant motion indoors or out with the movement of a gentle breeze or a gentle pull on its counterweight. Hand decorated, weather resistant. **BB35,967 $14.00**
Add $2.50 postage & handling

"Stop And Go" Blinking Light Is A Hit In Any Den Or Child's Room.

Adds exciting dimension to any room, college dorm or as a super retail store display. ***18" light blinks yellow, red and green at random.*** Wood frame, vinyl hood, 110 V. **BB35,987 $29.95**
Add $2.50 postage & handling

Our "Bug Box."

Here's a unique way of observing insects and specimens. Acrylic boxes have a magnifier built into the cover. Available in 2 sizes, ***packed in bags of 25 boxes.***

1" square box with 4X magnifier BB35,048 $11.95
1½" square box with 3X magnifier BB35,049 $22.95
Add $2.50 postage & handling

ORDER BY PHONE

Call (609) 573-6250

Use VISA, MasterCard, Diners Club, Amer. Exp. or Carte Blanche. Call anytime, 24 hours a day.

Most orders shipped within 48 hours.

SEND FOR FREE 60 PAGE CATALOG

Edmund Scientific

Thousands of exclusive, unique and exciting values. Something educational, fascinating and useful for every hobbyist, gadgeteer, student and educator.

Make Your Own Personal Solar Music Box. Plays A Merry Tune, Powered By Heat From A Light Bulb Or The Sun.

Create your own music box with this precision, mini movement, powwered by a 400mA solar cell. 2¼ x 1⅞," 4" wire leads.

Choice of 5 tunes. **Each $10.95**
BB35,218 "It's A Small World"
BB35,215 "Memory" (From "Cats")
BB35,219 "Teach The World To Sing"; BB35,216 "Love Story"
BB35,217 "Lara's Theme" **(please specify)**

Encapsulated solar cell, protected cell to drive above movement, 1¾" x 2⅞," 36" leads. **BB35,397 $8.00**
Add $2.50 for postage and handling

A Simple Touch, Your Lamp Is Lit! Another Touch, Your Lamp Goes Off!

Fantastic! ***Works on all lamps.*** No more fumbling in the dark for the light switch. Gives 3 levels of brightness from ***any*** incandescent bulb. To turn on your lamp, a simple touch as a night light; twice for half brightness; three times for full brightness. The fourth touch turns if off. UL listed. **BB35,997 $17.95**
Add $2.50 for postage and handling

This Clever Gadget Will Tell You How High You Are.

Whether you're driving cross country or hiking in the mountains, this Altimeter will tell you how high you are. Shows elevation from sea level to 15,000 feet. Can be mounted to dashboard with self sticking tape (incl.) or has pre-drilled screw holes. Also has built-in barometer. With case for hikers and bikers. ***Reg. $24.95***
Add $2.50 for postage and handling. **BB34,544 $19.95**

65 Piece Lab Set Assortment – Special Buy!

A super bargain every chemist can use in the lab and at home. It's surplus, but brand new. Giant assortment includes test tubes, vials, measuring cups, bottles with caps, flasks, beakers, pipettes, squeeze bottles and more. Assorted sizes and quantities. **BB35,474 $24.95**
Add $2.50 for postage and handling

Pocket Pointer – Handy Aid For Teachers, Lecturers, Executives.

Here's a handy accessory for teachers and executives – unbeatable for pointing to highlights on movies, charts, blackboard lessons,

← EXTENDS TO 25" →

demonstrations. ***Extends to 25," collapses to only 5."*** Chrome with pocket clip and pointer cap. **BB35,965 $3.95**
Add $1.00 for postage and handling

Protection From Would Be Attackers With Authentic 'One Mile' Scotland Yard Whistle.

The modern day version of the famous 1870 Sherlock Holmes reed whistle, made in England. You'll feel more secure in dangerous areas with your personal alarm that produces a piercing sound with a 1 mile range that would detract would be attackers. Brass, nickel plated. **BB35,518 $5.95**
Add $2.50 for postage and handling.

Digital Thermometer Reads How Cold It Is Outside.

34.0

DIGITAL THERMOMETER

This new high-tech marvel reads **temperature in your home and outside, too. Can** be wall mounted – just extend the 5 ft. **wire sensor out the** window **and close the window. Operates on one 9V battery (not incl.). Gives readings from –40°F to 199°F, measures 2x3x2¼."** ***Reg. $24.95***
Add $2.50 for postage and handling **BB34,005 $19.95**

Cannonball Whistle Recreates The Authentic Five Chime Steam Engine Sound.

Beautifully polished all-aluminum train whistle will take you on a trip to yesteryear when the steam engine train was king. 9½" long. Weighs just three ounces. Makes an excellent gift for railroaders of all ages. Includes instructions on how to simulate train hiss and other train sounds.

BB34,618 $24.95
Add $2.50 for postage and handling

No Risk Guarantee! If you are not completely satisfied with your purchase, return the merchandise in its original package and we will cheerfully refund your money in full. **We back our products!** Our 30 day unconditional guarantee means you take no risk on any product you buy from us.

Edmund Scientific Co.
Dept. 2102, BB10 Edscorp Bldg., Barrington, NJ 08007

Edmund Scientific Co., Dept. 2102
BB10 Edscorp Bldg., Barrington, NJ 08007

Method of Payment:
☐ Check enclosed
☐ MasterCard
☐ American Express
☐ VISA
☐ Diners Club
☐ Carte Blanche

STOCK NO.	QTY.	PRICE

Exp. Date

Card Number

☐ **SEND FREE 60 PAGE CATALOG**

TOTAL PRICE________

Add Shipping Charges________

In NJ Add 6% Sales Tax________

Total Enclosed________

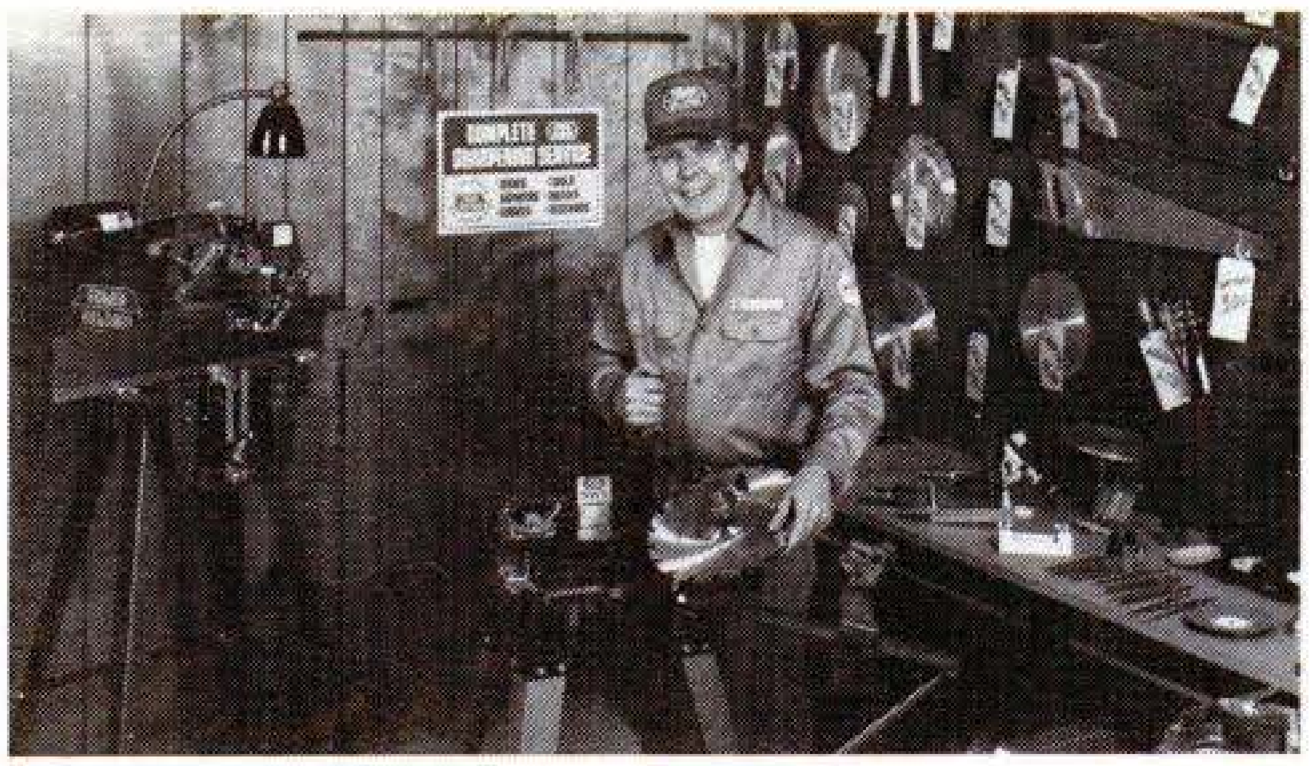
Signature________

Name________

Address________

City________ State________ Zip________

SERVING HOBBYISTS SINCE 1942



Be Your Own Boss and Make

$18.00 to $30.00 AN HOUR!

Your FREE Lifetime Security Fact Kit tells you how to make $18.00 to $30.00 an hour in your own Foley-Belsaw Full-Service Saw and Tool Sharpening Business. Your FREE Fact Kit explains how you can:

- **be your own BOSS!**
- **work full time or part time, right at home.**
- **do work you enjoy and take pride in.**
- **operate a CASH business where 90¢ of every dollar you take in is clear CASH profit.**

And it is *so easy* to learn. Foley-Belsaw gives you all the facts and instructions. No experience or special training is necessary. Foley-Belsaw tells you everything you need to know to be successful.

And there's plenty of business available in your area. You will be able to sharpen all types of saws, garden and shop tools for home, farm and industry.

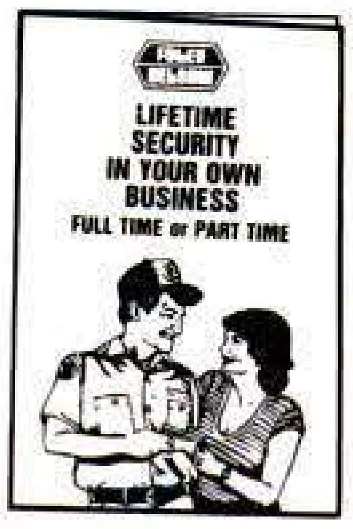
You will be able to set your own hours and not have to worry about layoffs and strikes. And there are no franchise fees. Any age person can succeed.

But you've got to get the FACTS before you can get started. So write NOW for your FREE Lifetime Security Fact Kit. It's yours to keep with NO OBLIGATION.

. . . send NOW for your FREE Lifetime Security Fact Kit!

FOLEY BELSAW

FREE LIFETIME SECURITY FACT KIT



The Foley-Belsaw Co.
20333 Field Bldg.
Kansas City, MO 64111

☐ **YES**, I want to know more!
Please rush my FREE Lifetime Security Fact Kit.

Name

Address

City State Zip

( ) Area Code Phone

AURORA AWARD WINNER
MOST ENERGY EFFICIENT RESIDENCE

American Ingenuity has developed an advanced building method for geodesic domes. Kits contain component building panels of steel/fiber reinforced concrete bonded to polystyrene foam insulation. Also available screen dome kits. Send $5 for a planning kit.

AMERICAN INGENUITY, INC.
3500 Harlock Road, Melbourne, Florida 32935

BE A BOOKKEEPER

If you are bored with your present job, brand new skills in Bookkeeping and General Accounting could be for you. Learn at home. Full or part-time. Send name, address for free booklet.

COMMERCIAL TECHNICAL INSTITUTE, Dept. 311-106
1500 Cardinal Dr., Little Falls, N.J. 07424

GERMAN W.W.II HELMET
(ORIGINAL-Repainted)

ONLY $50 (3.00)
DELIVERY CHARGE IN PARENTHESIS

MONEY BACK IF NOT SATISFIED

COLLECTORS! SEND FOR FREE CATALOG
W.W. II Medals, Civil War Hats, Flags, etc. 100's of items
The COLLECTOR'S ARMOURY, Inc., Dept. *PS*
800 SLATERS LANE, P.O. BOX 1061, ALEXANDRIA, VIRGINIA 22313

FOR SPEEDIER DELIVERY PLEASE USE YOUR ZIP CODE

CASH IN ON YOUR SKILLS

Earn Big Bucks In Your Home Or Garage!

Users Report Earnings Up To $75.00/HR And More.

Do quality, precision work just like the big shops.

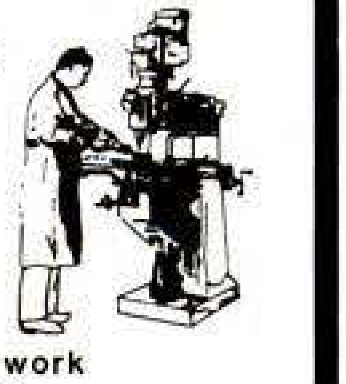
Now you can run INDUSTRIAL 220 volt 3Ø equipment in your home on 220 volt 1Ø power.

Do it yourself "PHASE CONVERTER KIT" is simple and fun to put together. (Approx. 3 Hrs. Req'd)

MODEL		COST
$\frac{1}{4}$-$\frac{1}{2}$	HP	$59.95
$\frac{1}{2}$-1	HP	$69.95
1-3	HP	$79.95
3-5	HP	$79.95
5-7 $\frac{1}{2}$	HP	$89.95
7 $\frac{1}{2}$-10	HP	$99.95

Send check or money order to
CII
521 West 90th St.
Minneapolis, Minnesota 55420
INCLUDE: Name, Address and Model #.
Add $5.00 shipping and handling.

PHASE CONVERTER



FACTORY DIRECT GRANDFATHER CLOCKS

Do-It-Yourself Clock Kits

Prices Starting Under $300

(including movement and dial)

OR

Completely Assembled and Finished

- Solid 3/4" hardwoods: black walnut, cherry, oak
- Heirloom quality
- Solid brass West German chiming movements and dials
- Easy to assemble kits or completely assembled and finished
- Money back guarantee

SEND $1 FOR 32-PAGE FULL COLOR CATALOG

EMPEROR® CLOCK COMPANY
WORLD'S LARGEST MANUFACTURER OF GRANDFATHER CLOCKS
Dept. 2119, Emperor Industrial Park
Fairhope, Alabama 36532 • Phone 1-205-928-2316

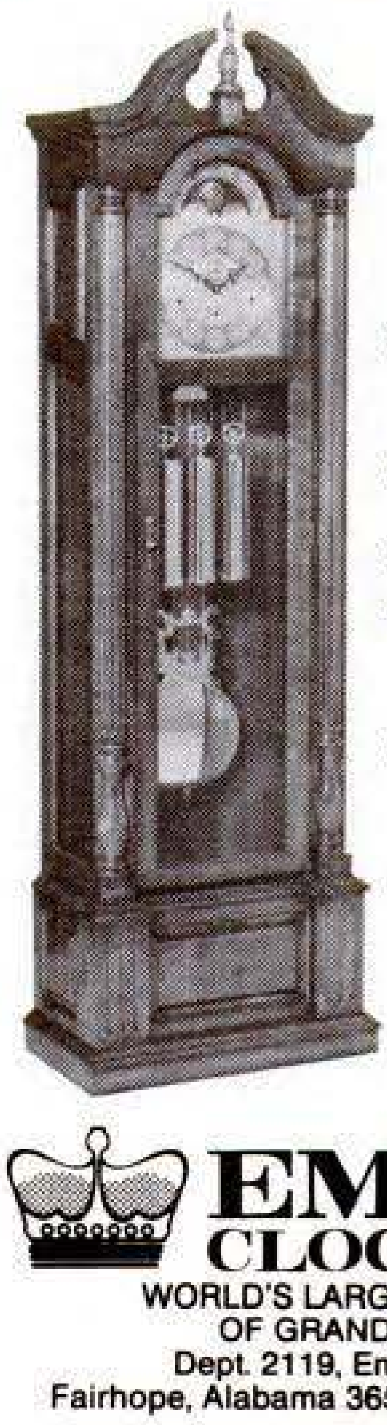
I am interested in ☐ Finished Clocks
☐ Do-It-Yourself Kits

Name

Street

City

State Zip
(please print)



BEST BUY!

EASY-TO-ASSEMBLE-KITS
In Stock for Immed. Shipping or Pick-up.

ONLY $425 F.O.B. Broomall, PA for 3'6" diam. (hts. 8' 1½" to 8' 9½")

Comparable savings on diams. from 4' to 7'.
Kits available to fit any floor-to-floor hts.

Now! Showroom & Warehouse locations in:

Pomona, CA
(714) 598-5766
Sarasota, FL
(813) 923-1479
Houston, TX
(713) 789-0648
Chicago, IL
(312) 952-9010

© The Iron Shop 1977, '82

People who've looked everywhere tell us there isn't another spiral stair around that touches our combination of price and quality of materials and workmanship. We believe it!

CALL OR WRITE FOR FREE BROCHURE:

To: The Iron Shop, Dept **PS106** Box 128, 400 Reed Road,
Broomall, Pa 19008 Our Tel: (215) 544-7100.

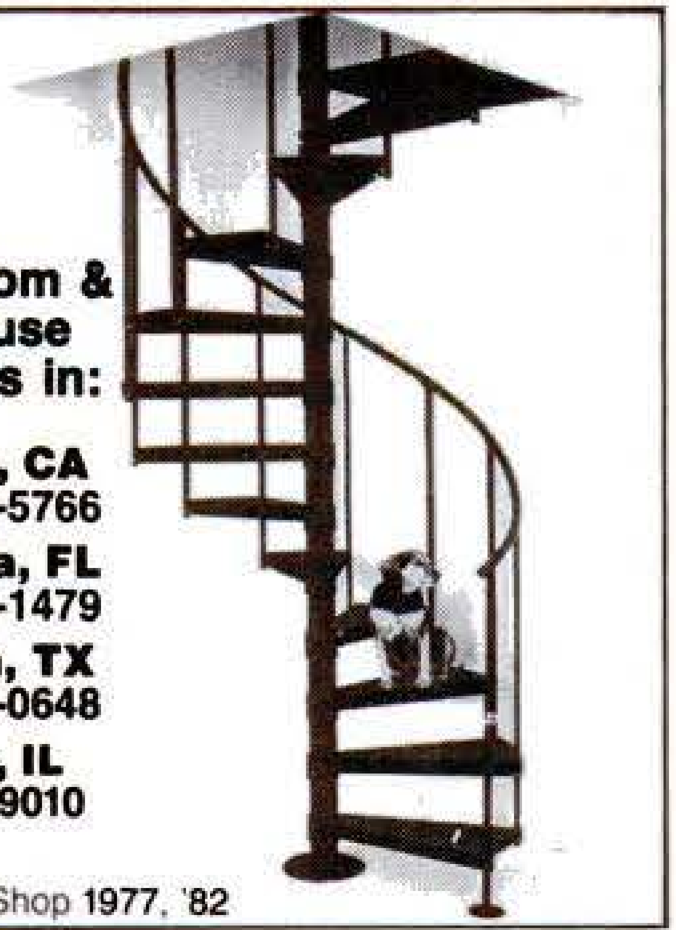
Name

Street

City State Zip

We accept MasterCard, VISA and AMEX.

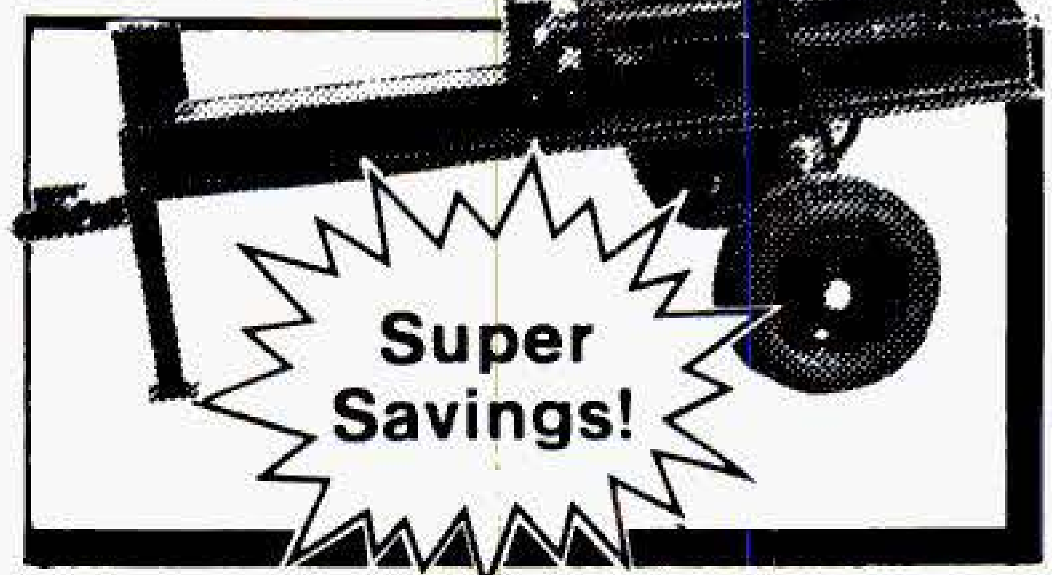
THE IRON SHOP®
MANUFACTURERS



Call 1-800-533-5545 today and . . .

SAVE 20-50%

On These Name Brand Parts, Tools & Equipment!



SUPER TOUGH
Heavy Duty Log Splitters

SALE!

16 Ton Model, #1134	$729.00
New! 20 Ton Vertical, #1160	$824.00
24 Ton, Low Profile, #1142	$1179.00

★ Comes with 2-stage pumps, heavy duty slides & beams and large oil tanks.

Gas Engines
Always the Lowest Prices And the Largest Selection!

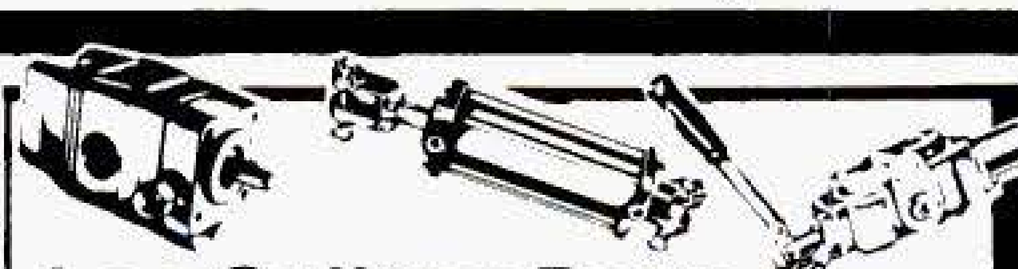
One Year Warranty!

Gas Engines

Horizontal	SALE!
5 Hp. Tecumseh ¾" shaft, #6051	$134.95
5 Hp. Briggs, ¾" shaft, #6052	$139.95
8 Hp. Tecumseh, cast iron sleeve, 6081	$192.95
8 Hp. Briggs, 1" shaft, #6080	$223.95
10 Hp. Tecumseh, cast iron sleeve, 6010	$219.95
10 Hp. Tecumseh, elec. start, #60101	$259.95

3-20 Hp. Horizontal & Vertical engines available at SUPER LOW DISCOUNT PRICES!

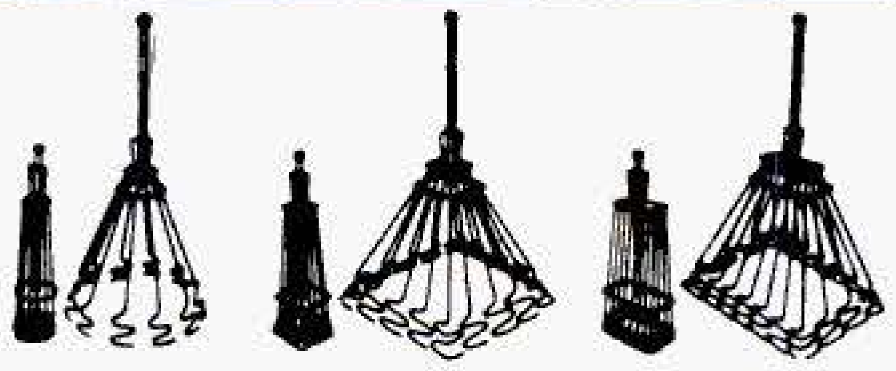
Send For Your FREE Catalog!



Log Splitter Parts

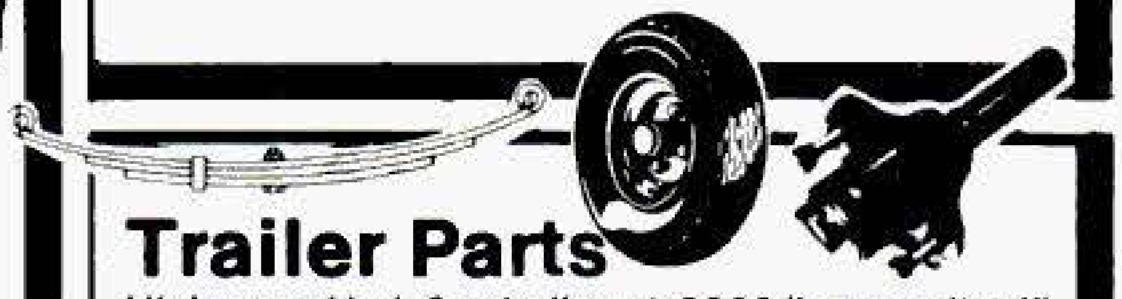
	SALE!
11 Gpm 2 Stage Pump, #1012	$83.95
13 Gpm 2 Stage Pump, #1053	$113.95
16 Gpm 2 Stage Pump, #1056	$126.95
22 Gpm 2 Stage Pump, #1017	$219.95
Standard 4-Way Control Valve, #2010	$41.95
Auto Detent Valve, #2020	$47.50
4x24x2" Welded Cyl., #902424	$99.95
5x24x2" Tie Rod Cyl., #909524	$182.95

Much More in Stock at Low Discount Prices!



CHIMNEY CLEANERS

Item	Type	Fits This Size & All Sizes In Between	SALE! Price
1540	Round	6", 7", 8", 9", 10", 11"	$16.75
1541	Square	6", 7", 8", 9", 10", 11"	$16.75
1542	Rectangular	6 × 10, 7 × 11, 8 × 12 9 × 13, 10 × 14	$16.75



Trailer Parts

High speed hub & spindle set, 2000 lb. capacity. 4" bolt circle, 4 hole, 2 hubs & 2 spindles, dust caps, tapered bearings, lug bolts & cotter pins **$34.95/set**

High speed trailer wheels & tires. Fits all 4 hole boat & snowmobile trailers.

Item#	Size	Ply	Cap.	Sale	tire only
1211	480x8	4	590 lbs.	$19.95	$15.95
1212	570x8	4	715 lbs.	$29.95	$24.95
1216	480x12	4	780 lbs.	$32.95	$24.95

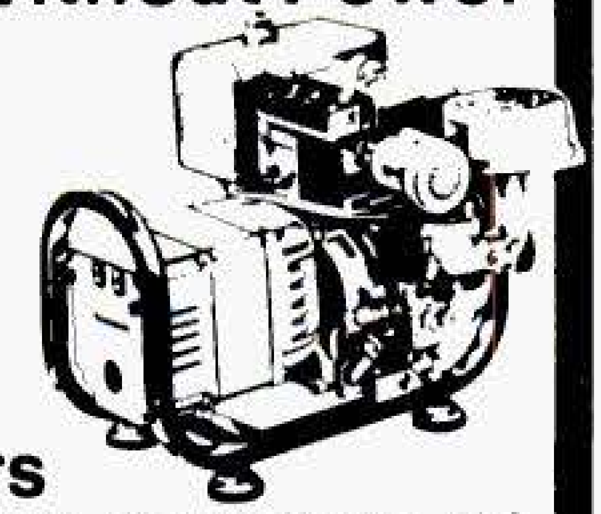
Trailer springs, 1¾" wide w/eye center of 25½"

Item#	Capacity	Springs	Leafs	Sale
1250	1000 lbs.	2	2	$20.00/pr.
1251	2000 lbs.	2	3	$22.00/pr.
1252	3000 lbs.	2	3	$25.00/pr.

Single Spring Set Shackle, Item# 1255 **$9.50/set**

Don't Be Without Power

Ideal for homeowners, farmers contractors & vacationers.
1 Year Warranty



Generators

4000 Watt. 8 Hp. Briggs. 33 amps @ 120 V. 16.6 amps @ 240 volts. List $1009.00. Item# **16402**

SALE! $397.95

4000 Watt, w/elec. start. List $1143. Item# **16403**

SALE! $474.95

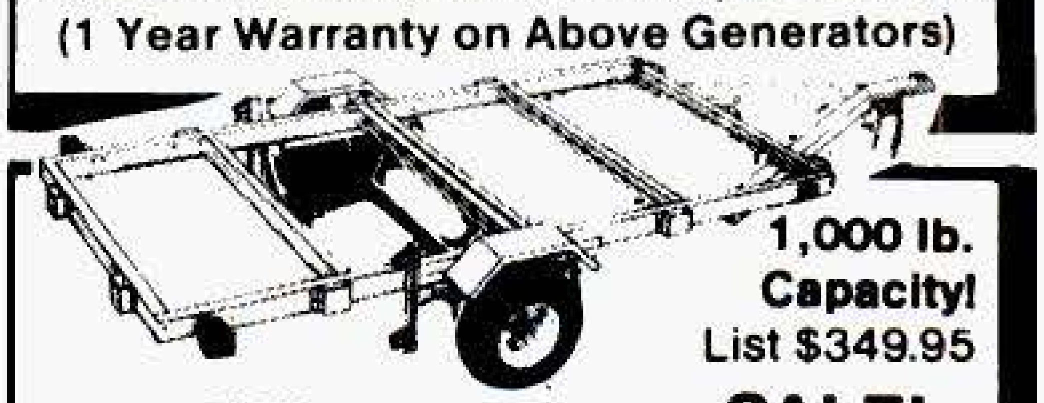
5000 Watt. 11 Hp. Briggs. 42 amps @ 120 V. 21 amps @ 240 volts. List $1174.00. Item# **16404**

SALE! $579.95

5000 Watt, w/elec. start. List $1299. Item# **16405**

All are at continuous watt rating. **$679.95**

(1 Year Warranty on Above Generators)



1,000 lb. Capacity!
List $349.95

Item# **1257**
Ship Wt. 222 lbs.

SALE! $179.95

4' x 8' Folding Trailer

Features:
- **Heavy steel frame with tough baked on**
- **enamel finish**
- **Leaf spring suspension for smooth ride**
- **Reinforced tongue for added stability**
- **1⅞" ball hitch**
- **Stake pockets so you can add 2x4 stakes**
- **Popular 480 x 8" high speed tires with**
- **4 bolt wheels**
- **Steel fenders**
- **4 solid rubber easy rolling casters**
- **All lights & reflectors included**

(must go truck freight collect)

Utility Trailer

SALE! $119.95

Complete road ready kit. Easy assembly with basic tools. Load capacity 1060 lbs. Bed size 40" × 48". Includes fenders. List $279.00. Item# **12542**

(will ship 48 states for $30.00)

Northern Hydraulics INC. Dept. 64630

801 East Cliff Road, Box 1219, Burnsville, Mn 55337
Call our order dept. at 1-800-533-5545
In Mn call 612-894-8310
N.C. & S.C. residents. visit our Charlotte store!

Phone Orders
Monday-Thursday 8am-8:30pm
Friday & Saturday 8am to 5:00pm
We Ship UPS, Bus or Truck

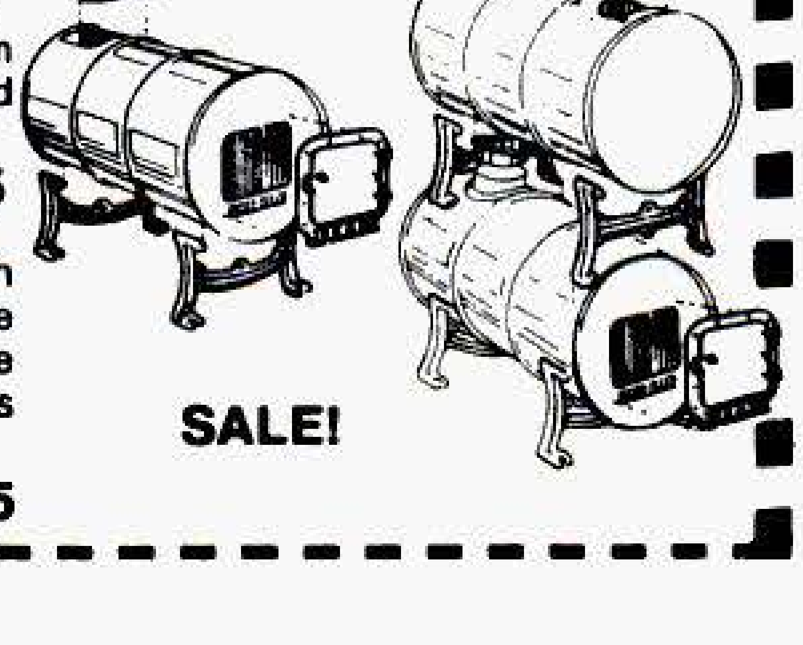
Prices Expire 11/30/86

MasterCard · VISA · DISCOVER

BARREL STOVE KITS

STANDARD KIT, 100% cast iron and will convert any 55 or 30 gallon barrel drum into an efficient and economical wood burning heater. A ***SUPER VALUE!***
#15056, Wt. 32 lbs., List $49.95.... **$19.95**

DOUBLE BARREL KIT, when used with above kit will convert it into a double barrel stove. The secondary gases are trapped and create greater efficiency as they travel through the top barrel.
#15057, Wt. 19 lbs, List $39.95..... **$12.95**



Your home workshop can PAY-OFF

BIG... START YOUR OWN MONEY MAKING BUSINESS!

Earn Extra Income Right At Home.

FOLEY BELSAW

3-IN-1 *Power Feed* Power Tool.

SEND FOR FACTS TODAY!

Planer Molder Saw

Three power tools in one – a real money-maker for you!

The Planer/Molder/Saw is a versatile piece of machinery. It turns out profitable precision molding, trim, flooring, furniture . . . in all popular patterns. Rips, planes, molds separately . . . or all at once. Used by individual home craftsman, cabinet and picture framing shops, lumber yards, contractors and carpenters.

Never before has there been a three-way, heavy-duty woodworker that does so many jobs for so little cost. Saws to width, planes to desired thickness, and molds to any choice of patterns. Cuts any molding pattern you desire. Provides trouble-free performance. And is so simple to operate even beginners can use it!

30-Day FREE Trial! SEND FOR EXCITING FACTS

NO OBLIGATION–NO SALESMAN WILL CALL

RUSH COUPON TODAY!

FOLEY-BELSAW CO.
90907 FIELD BLDG.
KANSAS CITY, MO. 64111

FOLEY BELSAW

Foley-Belsaw Co.
90907 Field Bldg.
Kansas City, Mo. 64111

FREE BOOK

☐ *YES, please send me the FREE Booklet that gives me complete facts about your Planer-Molder-Saw and full details on how I can qualify for a 30-Day Free Trial right in my own shop. I understand there is No Obligation and that No Salesman will call.*

Name ______

Address ______

City ______

State ______ **Zip** ______

TRUMARK®

225 YD. RANGE!
THE ORIGINAL (NEW)
New Handle Holds Ammo

AT DEALERS OR ORDER DIRECT ....POSTAGE PAID

$15.00 TOTAL — ALL (3) ITEMS
- FS-1 FOLDING SLINGSHOT WITH WRIST-BRACE
- RR-1 REPLACEMENT BANDS & LEATHER POUCH
- SA50 70 ROUNDS 1/2" TRACER BRAND AMMO

NO C.O.D. [FOREIGN ORDERS ADD $3.00 FOR AIRMAIL]

TRUMARK SLINGSHOTS: P.O. BOX 1517 R, BOULDER, CO. 80306 USA

The LONGWOOD Furnace —

5 Ways Better Than A Wood Stove!

1. Warm Floors because energy-saving design heats your basement.

2. Warm Rooms because it's a full-time, whole-house heating system.

3. Warm Mornings because 12-HR wood load heats all night long.

4. High Tech design offers high-efficiency, automatic operation.

5. Fuel Choices let you heat with wood, oil, gas or combination.

UL Listed

Early Order Bonus now in effect!

Send TODAY for FREE LONGWOOD Literature!

GARDEN WAY MFG.CO. Dept. A407
102nd St. and 9th Ave., Troy, N.Y. 12180

MAKE THIS SHADE FOR LESS THAN $75.00

Send $1.00 for our big catalog of stained glass supplies.

WHITTEMORE, Box 2065DE, HANOVER, MASS. 02339

Got a Minit? Make a Button!

with

Badge-A-Minit

It only takes a "minit" to enter the fast and easy, fun and profitable world of button-making with Badge-A-Minit. These 2¼" plastic coated buttons are fun to wear, fun to make and easy to sell at flea markets, fairs, conventions, sporting events, or anywhere people congregate. Supply buttons for community events, school clubs or churches. Button parts cost only pennies each, finished buttons sell for much more.

Only $26.95 gets you started with everything you need to make buttons.

Send today for our FREE colorful 48 page catalog PLUS a FREE 24 page book full of button-making ideas from Badge-A-Minit.

Badge-A-Minit

GUARANTEED

Badge-A-Minit Ltd. Dept. PS1086
348 North 30th Rd., Box 800, LaSalle, IL 61301
(815) 224-2090

☐ **SEND ME FREE the catalog and idea book!**
☐ YES, SEND ME the Badge-A-Minit starter kit for only $26.95 plus $1.75 shipping (IL. residents add $1.62 tax)

☐ Visa ☐ MasterCard

Credit Card No. ______

Exp. Date ______ Signature ______

Name ______

Address ______

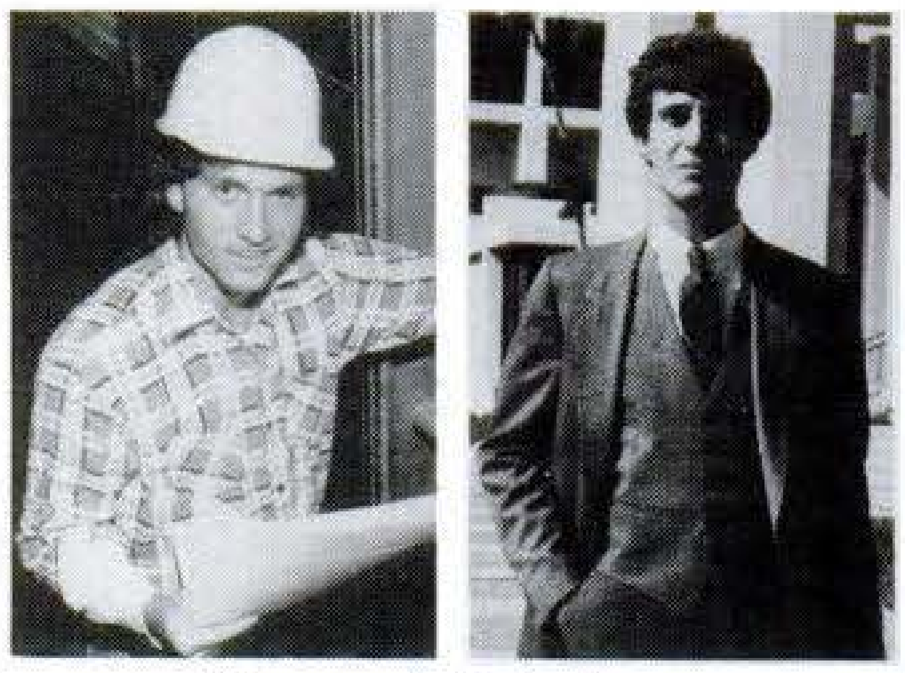
City ______

State ______ Zip ______

PLEASE PRINT

30 Ways to Help you Qualify for the Job You Want

Get your Specialized Associate Degree or Career Diploma Without Attending College ...at Home in Spare Time!



Now it's easy to train for a money-making career...even get a degree if you want...to help you get a better job. Find out what you need to know about any one of these programs with no obligation to buy anything, now or ever. No salesman will call. Just check the one program that interests you most. You will receive free facts, color brochure and information on employment opportunities.

No need to attend a College or University to get your Specialized Associate Degree or Career Diploma

Compare your present salary with the kind of money you could be making in any of the careers listed below. Whether you want an executive career or whether you want to work with your hands, now you can train at home through independent study.

It's easy!...It's fun!
You learn from specialists

You need no previous experience for any of the courses listed below. No need to change your daily routine or take time from family or job. And your instructors are as close as your telephone. Our staff of educators, consultants, administrators, authors and distinguished instructors are specialists in home-study training. So whether you choose an ASB or AST Degree or career training leading to a Diploma, you'll be a "class of one" with your exams graded by experts who offer comments and suggestions whenever needed. Call or send for free information on the career field that interests you most and how to train for it.

CALL TOLL-FREE
1-800-228-5300 Dept. PCS96

Call anytime—Operators to take your call 24 hours a day, 7 days a week. No cost. No obligation.

OR MAIL COUPON TODAY! 169ZB

ICS SINCE 1891 **International Correspondence Schools**
Scranton, Pennsylvania 18515 Dept. PCS96

Send free facts on how I can study at home for the career I have chosen. No obligation. No salesman will visit. **CHECK ONE CAREER ONLY.**

ASSOCIATE IN SPECIALIZED BUSINESS DEGREE PROGRAMS
- ☐ Business Management
- ☐ Accounting
- ☐ Business Management with option in Marketing
- ☐ Business Management with option in Finance

ASSOCIATE IN SPECIALIZED TECHNOLOGY DEGREE PROGRAMS
- ☐ Mechanical Engineering Technology
- ☐ Civil Engineering Technology
- ☐ Electrical Engineering Technology
- ☐ Electronics Technology

CAREER DIPLOMA PROGRAMS
- ☐ Computer Programming
- ☐ High School
- ☐ Catering/Gourmet Cooking
- ☐ Microcomputer Repair
- ☐ Auto Mechanics
- ☐ Bookkeeping
- ☐ Hotel/Restaurant Management
- ☐ Drafting
- ☐ Air Conditioning & Refrigeration
- ☐ Electronics
- ☐ Electrician
- ☐ Police Science
- ☐ Art
- ☐ Small Business Management
- ☐ Wildlife/Forestry Conservation
- ☐ Diesel Mechanics
- ☐ Gun Repair
- ☐ Motorcycle Repair
- ☐ Surveying & Mapping
- ☐ TV/VCR Repair
- ☐ Veterinary Assistant
- ☐ Travel Agent

These courses are offered by ICS and North American Correspondence Schools.

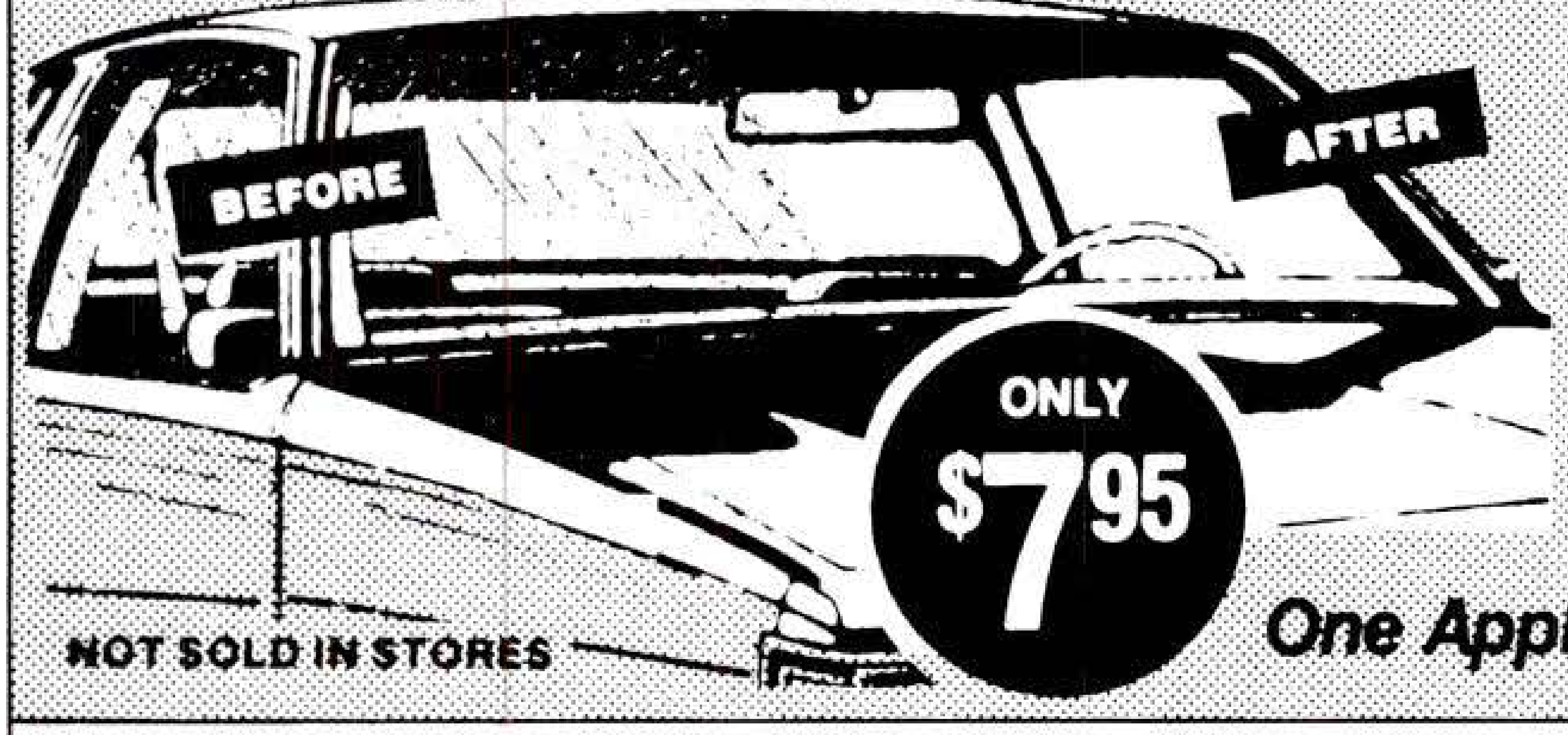
Name ______ **Age** ______

Address ______ **Apt. #** ______

City/State/Zip ______

EXCLUSIVE FORMULATION USED BY AIRLINES—NOW AVAILABLE TO CAR OWNERS

Glass Shield™ KEEPS *ALL* CAR WINDOWS PERFECTLY CLEAR AT *ALL* TIMES... *ABSOLUTELY NOTHING CAN STICK TO THEM...*



- **NOT SNOW** • **NOT SLEET**
- **NOT ICE** • **NOT GRIME**
- **NOT DIRT** • **NOT RAIN**
- **NOT BUGS** • **NOT TAR**
- **NOT SALT SPRAY**

One Application lasts for up to Six Months!

GLASS SHIELD utilizes the formulation now used by most commercial and private planes to insure a perfectly clear windshield regardless of how foul the weather.

WORKS LIKE MAGIC

You'll be amazed as you watch the elements hit your windshield and actually roll and bounce off every area of glass. It's not magic... it's GLASS SHIELD!

IMPROVED FOR CAR & BOAT OWNERS

The plane formulation was enhanced by adding ingredients that not only prevent snow, sleet and ice formation on cars, but also grime, dirt, bugs, tars and salt spray from adhering to your windshield and all glass areas, including side mirrors. You can now drive in the worst of weathers with the assurance that you'll enjoy even clearer visibility at all times without even using your wipers. AND, because GLASS SHIELD protects the entire glass area of your car, you enjoy far greater visibility than merely depending on your windshield wipers. Clearer and wider visibility insures elimination of "blind spots" and provides greater protection against road accidents for you and your family. GLASS SHIELD is made by the manufacturers of famous GLO-SHIELD, America's finest car finish.

AS SEEN ON NBC-TV

David Horowitz' Consumer Report Show

IT REALLY WORKS!

©1986 NC CORP.

Glass Shield™

- **STOPS ICE, SNOW AND SLEET FROM FORMING ON WINDSHIELD, ETC.**
- **ROAD TARS, GRIME, SALT SPRAY, DIRT AND BUGS ROLL RIGHT OFF.**
- ***FULL* WINDSHIELD, SIDE AND REAR WINDOW VISIBILITY PERFECTLY CLEAR AT ALL TIMES (not just wiper area).**
- **GREATER PROTECTION AGAINST ACCIDENTS FOR YOU AND YOUR FAMILY.**
- **ONE APPLICATION LASTS FOR UP TO 6 MONTHS.**
- **ONE BOTTLE PROTECTS SEVERAL CARS.**
- **SAFE FOR ALL CAR FINISHES.**
- **EXCELLENT FOR HOME WINDOWS. ELIMINATES CONSTANT WASHING**
- **PERFECT FOR BOATS, TOO. KEEPS SALT SPRAY OFF WINDOWS**

30 DAY MONEY BACK GUARANTEE

Howe Co., Dept. 534
10-10 44th Ave., L.I.C., NY 11101

Please rush me ____ bottles of GLASS SHIELD @ $7.95 (2 for $13.90, 4 for $25.95) Add $1.00 per order for postage & handling. N.Y. residents add sales tax. Enclosed is check or M.O. for $________, or charge to my ☐ VISA ☐ MASTER CARD

No ________________ Expire Date ________

Name ________________

Address ________________

City ________________

State ________________ Zip ________

WATER!

Have all the pure, fresh water you want FREE!

You can drill a water well in your backyard next weekend!

Over 99,000 home water wells drilled this easy, low-cost way since 1962!

FREE Color Brochure

CALL TOLL-FREE
1-800-821-7700
(Ask for Operator 5117)

Or Clip Coupon and Mail Today!

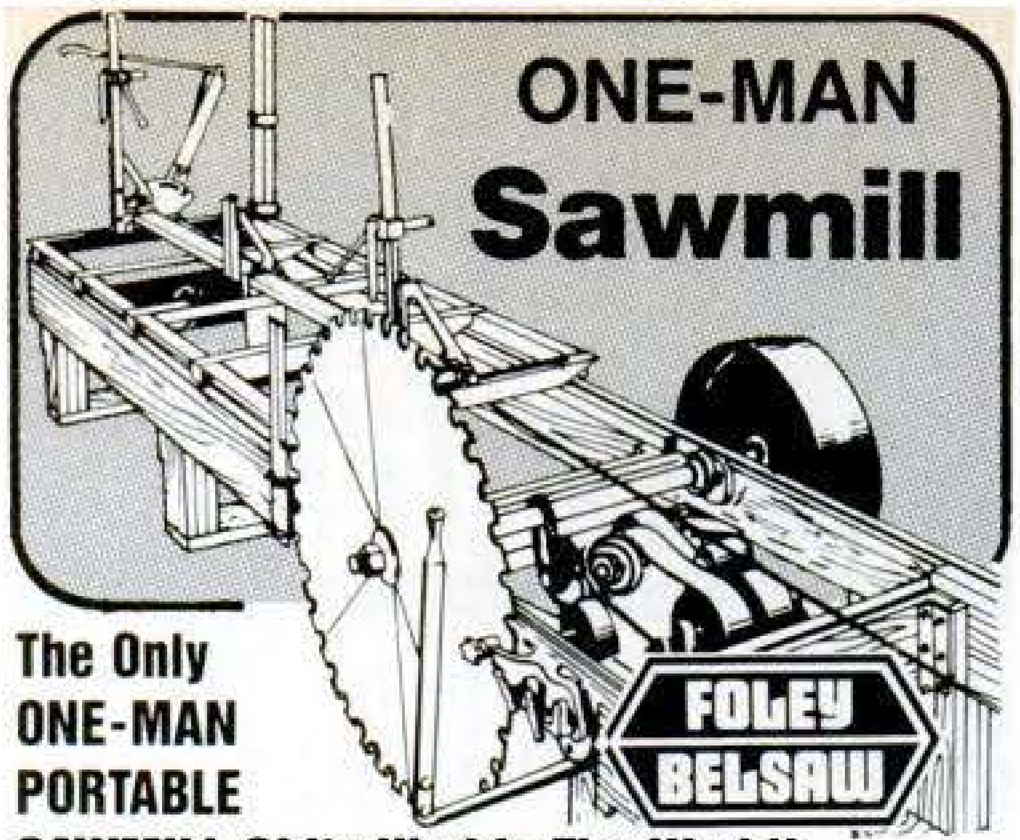
DeepRock
Anderson Road
Opelika, Alabama 36802

Please mail your FREE Brochure.

Print Name

Address

City/State/Zip © 1986 5117



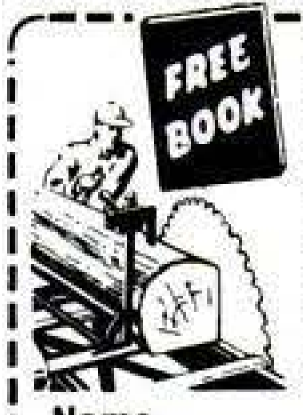
ONE-MAN Sawmill

The Only ONE-MAN PORTABLE SAWMILL Of Its Kind In The World!

FOLEY BELSAW

If you need good, high-quality lumber, don't let inflated lumber prices stop your important building projects. The Foley-Belsaw goes right to the trees and turns out smooth, true-cut lumber... even beginners get excellent results. Just one man (no crew needed) can easily cut enough on weekends to save hundreds of dollars over high lumberyard prices. For power use tractor PTO or other low HP diesel or electric unit. Factory-direct selling keeps price low, and convenient time payments may be arranged.

Send for FREE BOOK! Just mail coupon below for *"How To Saw Lumber"* booklet and complete facts on the One-Man Sawmill. There is NO Obligation and NO Salesman Will Call on you. Do It TODAY!



Foley-Belsaw Co.
30676 Field Building
Kansas City, Mo. 64111

FOLEY BELSAW

Please send all facts and details in your FREE BOOK "How To Saw Lumber". I understand there is No Obligation and that No Salesman will call on me.

Name

Address

City-State **Zip**

Popular Science Indexes
Box 2027, Latham, N.Y. 12111

Enclosed is a total of $______ (check or money order) Please send
☐'85 ☐'84 ☐'83 ☐'82 ☐'81 ☐'80 ☐'79
☐'78 ☐'77 ☐'76 ☐'75 ☐'74 ☐'73 ☐'72
($1 75 each) ☐All 14 indexes (1972-1985) for $14 ☐Five indexes $5

Name

Address

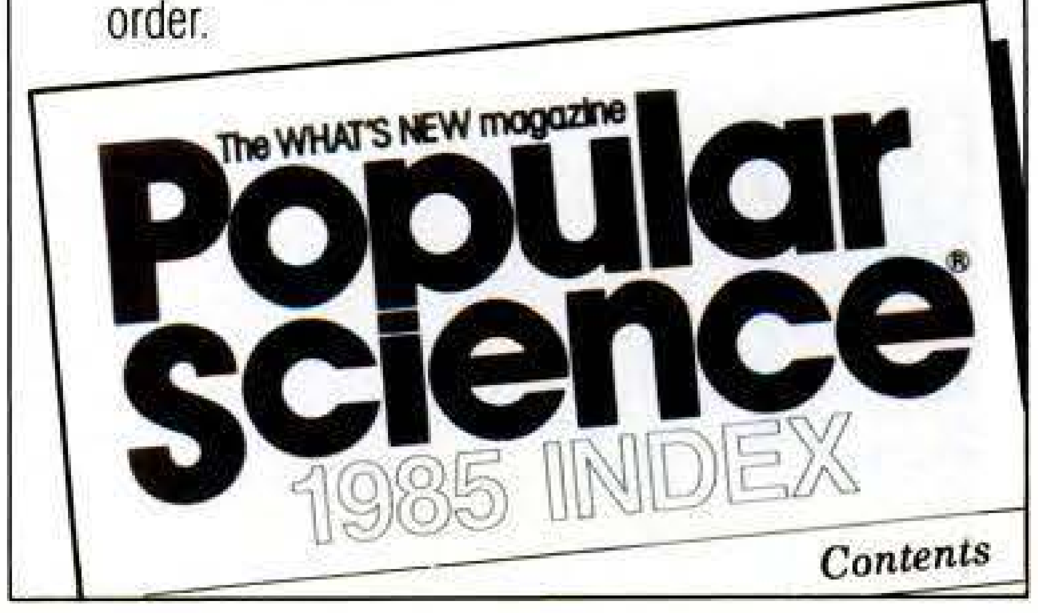
City

State Zip

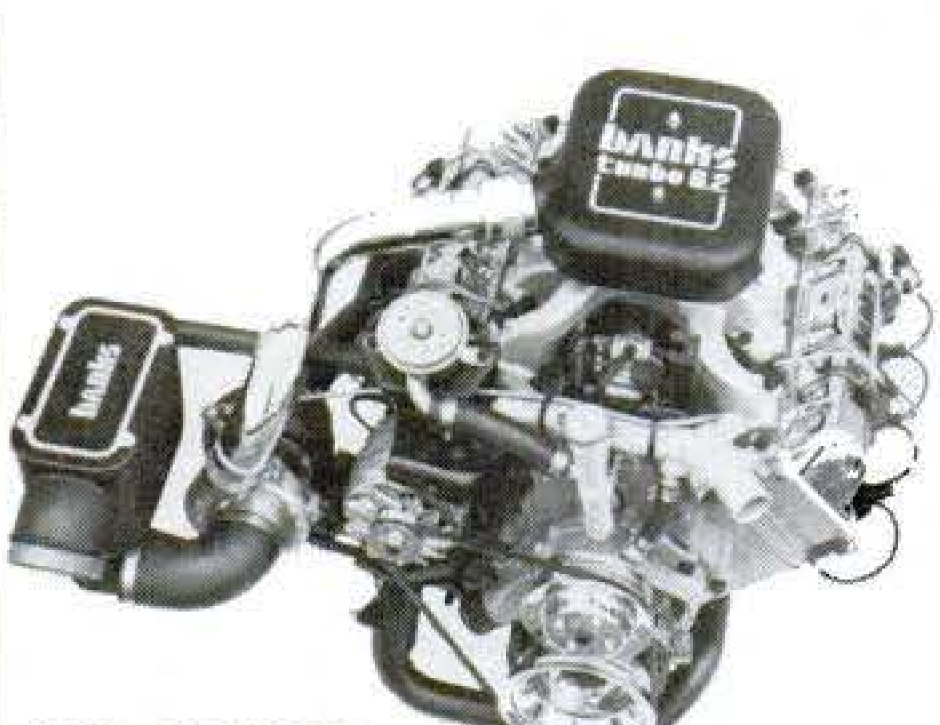
(Prices above include postage and handling. Allow about 4 weeks for delivery.)

YOU SAW IT IN POPULAR SCIENCE —BUT WHEN?

Nothing is more frustrating than trying to find that article on the new super-smart cars or satellite TV antennas, or locating any other informative article or item that appeared in POPULAR SCIENCE in 1985. That's why you'll want a handy 1985 POPULAR SCIENCE Index. And to help you make use of your older magazines, or to find a PS reference quickly at the library, complete your set of indexes, still available from 1972 to date. Fill out the order form above or a larger sheet and send with check or money order.



DIESEL POWER THAT *FEELS GOOD*



GM 6.2L TURBO
FORD 6.9L TURBO ALSO AVAILABLE

- THE ONLY TURBO SYSTEMS EMISSIONS LEGAL IN ALL 50 STATES
- UP TO 50% MORE HORSEPOWER
- 12 MONTH WARRANTY
- DEALERS NATIONWIDE
- YOUR POWER SOURCE "SINCE 1958"

banks™
Gale Banks Engineering
546 Duggan Avenue, Dept. 651
Azusa, Ca. 91702 (818) 969-9605

HI-TECH SALES, LTD.

STATE OF THE ART PRODUCTS

PORTABLE GENERATORS AT WHOLESALE PRICES

1000 WATT CAMPING GENERATOR

3 H.P.

BRIGGS & STRATTON

RETAIL $649⁰⁰
only **$299**

- 1000 WATT CONTINUOUS POWER
- 120 DUPLEX RECEPTACLE
- 10 AMP 12 VOLT D.C. BATTERY CHARGING WITH LIGHT & CABLES
- SHUT-OFF SWITCH
- LIGHTWEIGHT—EASILY PORTABLE

4000 WATT HOME GENERATOR

8 H.P.

BRIGGS & STRATTON

RETAIL $949⁰⁰
only **$399**

- 4000 WATT CONTINUOUS POWER
- 120 & 240 VOLT DUPLEX RECEPTACLES
- CIRCUIT BREAKER PROTECTED
- CONVENIENT CARRYING HANDLE

STANDARD FEATURES—BOTH UNITS

- Power for Furnace, Sump Pumps, Appliances, Tools, Power Failures, etc. - (To Rated Watts)
- Nationwide Service—1 yr. Limited Warranty
- Briggs & Stratton 4 Cycle Engine
- Spark Arrestor Lo-Tone Muffler
- AC and DC Circuit Breakers
- Quality Copper Windings
- Sealed Ball Bearings
- Vibration Dampers
- Finest Quality, Factory New—Made in U.S.A.
- Hi-Tech Engineering and Design

TO PLACE ORDER OR FOR MORE INFORMATION CALL MON-FRI 8AM-5PM - CENTRAL TIME

VISA MasterCard AMERICAN EXPRESS

TOLL FREE: 1-800-334-5959
IN ILLINOIS: (312) 451-7550
SHIPPED FREIGHT COLLECT • ILL. RESIDENTS ADD 7% SALES TAX

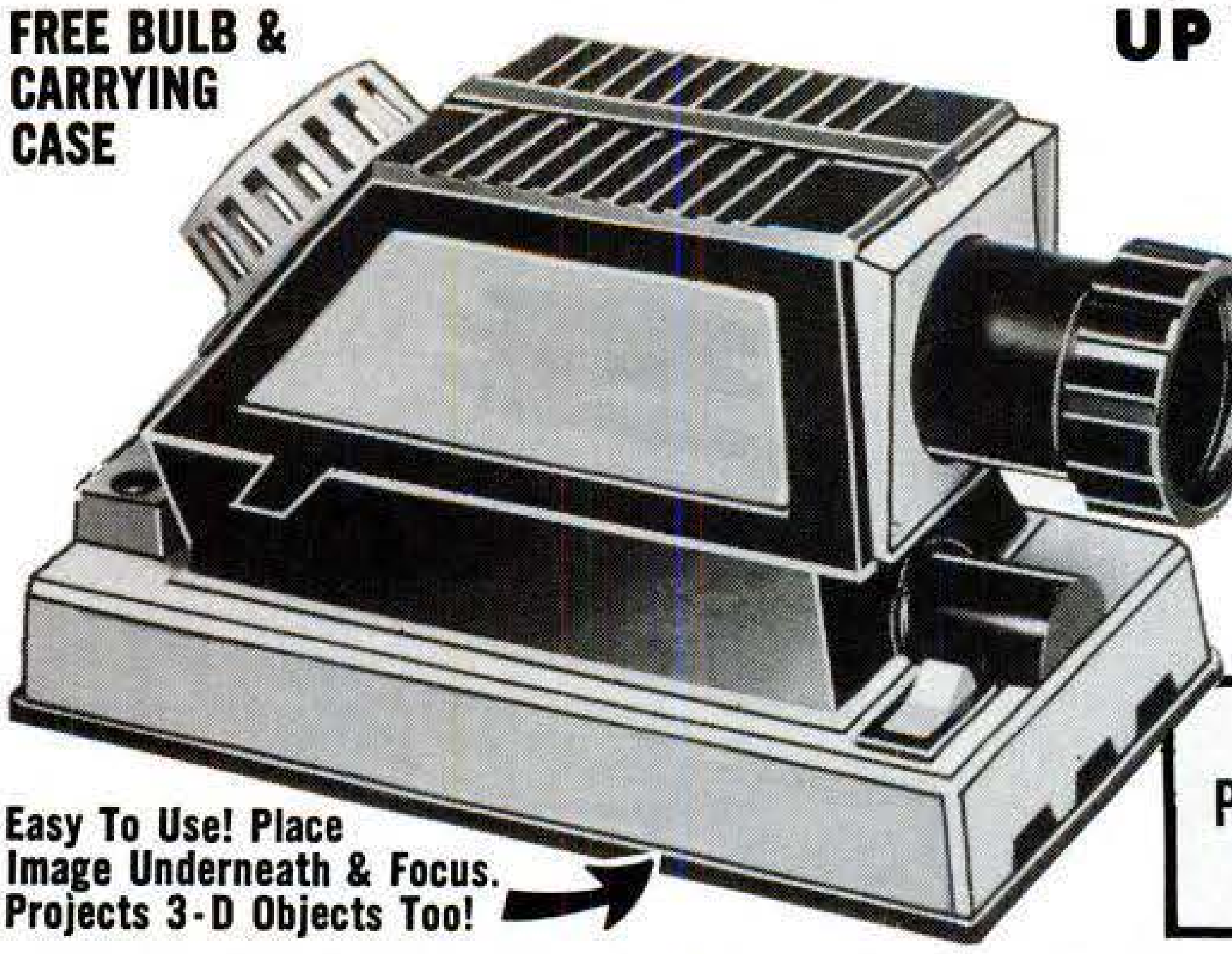
HI-TECH SALES, LTD.

P.O. BOX 1567
BENSENVILLE, ILLINOIS 60106

COPY & ENLARGE Patterns, Plans, Drawings

FREE BULB & CARRYING CASE

UP TO 25x's BIGGER!



PROJECTS SHARP IMAGES ONTO:

- **WALL**
- **WOOD**
- **PAPER**
- **FABRIC**
- **SCREEN**

Projects Photos, Prints, Stamps, Coins And Gems In Natural Color

Easy To Use! Place Image Underneath & Focus. Projects 3-D Objects Too!

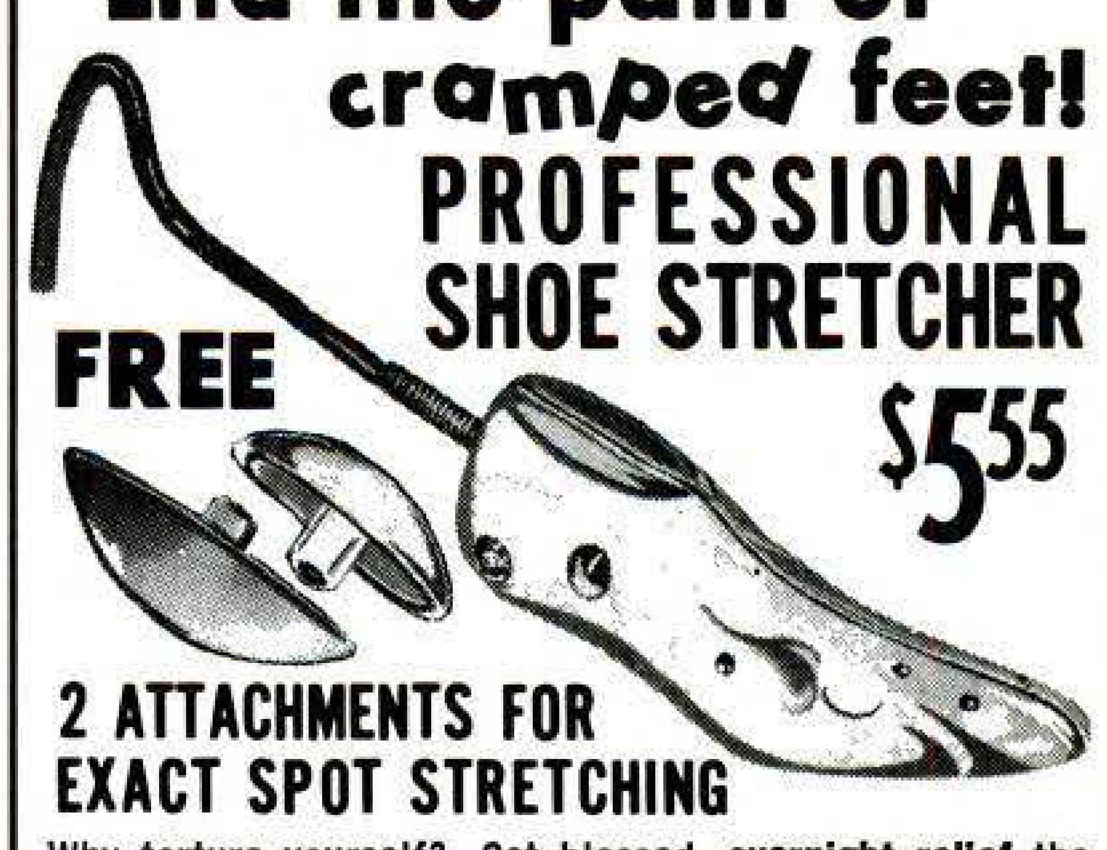
IDEAL FOR WOOD WORK, ARTS & CRAFTS OR NEEDLEPOINTING

Makes a real artist out of anyone! Place any object, design or picture under the famous EPISCOPE Projector . . . Switch on . . . it projects to wall, or any other object in front! Crisply projects even 3-Dimensional objects like sea shells, medallions, coins. Turn living insects into a live science lesson for the kids! **Really indispensable for the craftsperson.** Ideal for needlepointers, woodworkers, etc. Choose precisely the enlargement you want with the adjustable lens. Crafted from **Hi-Impact materials and metal** . . . made for a litetime of fun and projects. Plug into any ordinary socket. On-off Switch and special **40 Watt Bulb included. Plugs into ordinary outlet.** Easy to follow instructions and ideas for use also included. **Projects color postcard, snapshots, even slides!**

No. 4500A—Episcope Projector $16.95
EXTRA BULBS FOR YOUR PROJECTOR ONLY .... $ 2.00

End the pain of cramped feet!

PROFESSIONAL SHOE STRETCHER



$5.55

2 ATTACHMENTS FOR EXACT SPOT STRETCHING

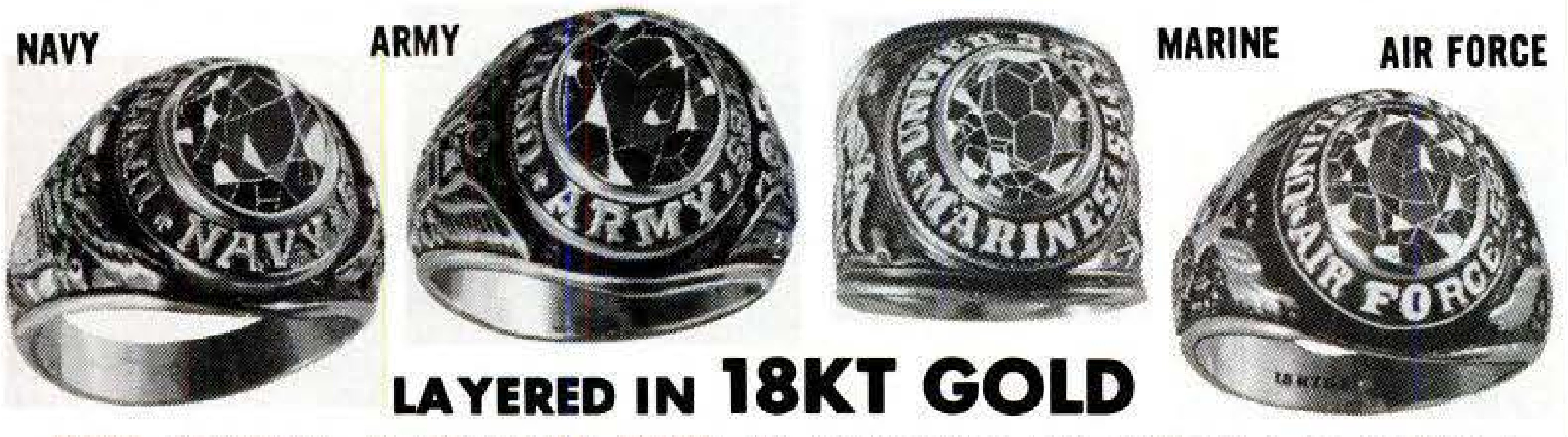
Why torture yourself? Get blessed, **overnight relief** the professional way. Enjoy a custom fit that will have your aching feet dancing for joy! Gently stretches and widens tight shoes. **Crafted from Genuine HARDWOODS** with an **E-Z Twist METAL HANDLE.** Comes with **2 NYLON SPOT RELIEVERS** . . . relieves pressure on bunions and corns. Pays for itself . . . no more trips to shoemaker. Takes the **"ouch"** out of breaking in new shoes. Don't suffer another day! **SPECIFY SIZE AND SEX WHEN ORDERING.**

Mens Regular (7D - 11A)	**Mens Large (10B - 14D)**
Ladies Regular (5B - 8A)	**Ladies Large (8B - 11A)**

No. 3066—Professional Shoe Stretcher 5.55
SPECIAL: 2 for $9.85

★★★★★★★★★ YOUR VERY OWN ★★★★★★★★★

ARMED SERVICES RINGS



LAYERED IN 18KT GOLD

SET WITH A RUBY-RED 3 CARAT FACETED STONE

IT'S OFFICIAL! Now, you can get an ARMY, NAVY, MARINE or AIR FORCE RING, no matter how long it has been since you served! Here's the ring you always wanted — so rugged . . . so manly and so finely detailed. Each one has **deeply sculpted official insignia** and symbols for that particular branch of service. Electroplated in GENUINE 18 KT GOLD . . . not ordinary plating but certified **HEAVY GOLD Electroplate** that will last and last! Big, 3 CARAT Multi-faceted, **Ruby-Red Stone.** It's the ring you can really wear with pride because you served your country well. Available in sizes 7-13.

WHEN ORDERING: SEND SIZE OR A SLIP OF PAPER CUT TO YOUR SIZE —
BE SURE TO SPECIFY ARMY, NAVY, MARINE OR AIR FORCE

No. 5623—Armed Services Ring $12.95
Special: Two only $22.95

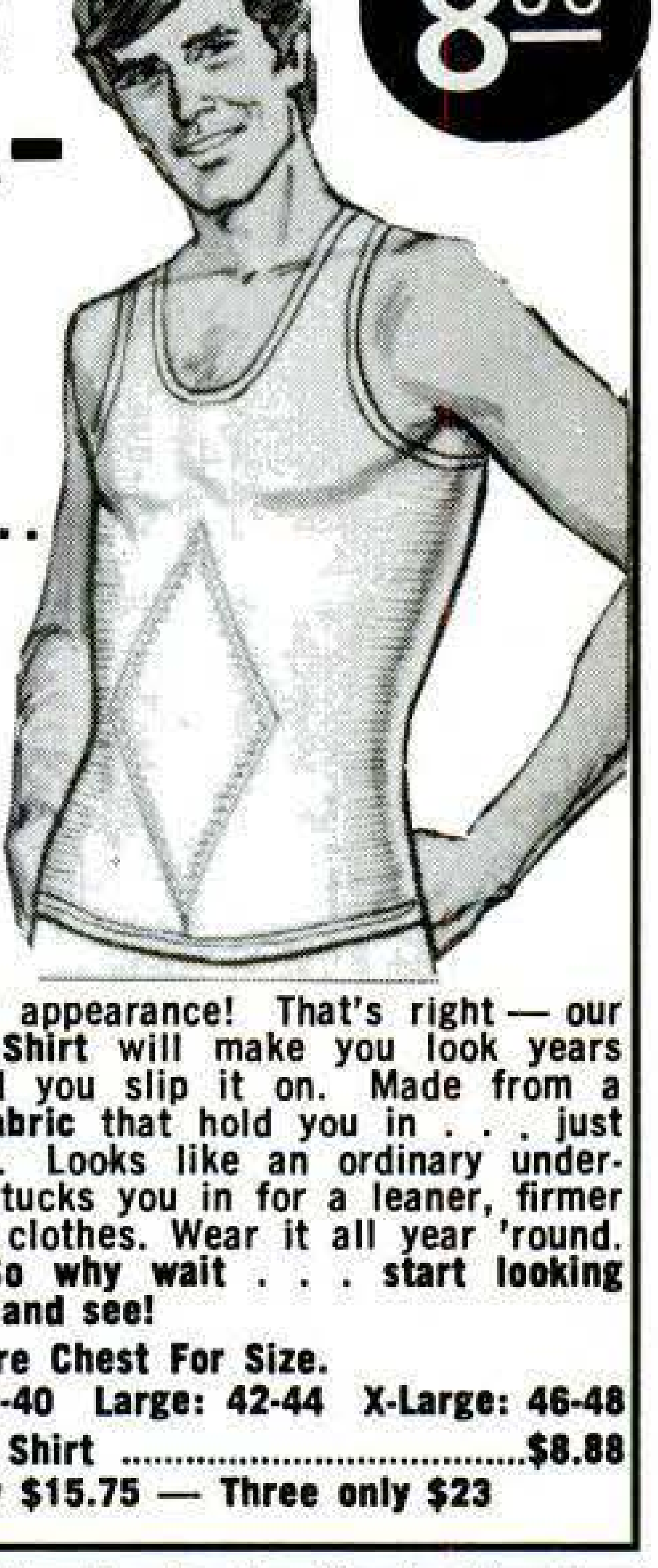
You Won't Believe It's You!

8.88

INSTA-TRIM

The Shirt That INSTANTLY Lets You Look . . . SLIM 'n' TRIM

Before
After



Take years from your appearance! That's right — our exclusive **INSTATRIM Shirt** will make you look years younger the second you slip it on. Made from a special **Power Knit Fabric** that hold you in . . . just like a "second skin". Looks like an ordinary undershirt but it nips and tucks you in for a leaner, firmer look. Invisible under clothes. Wear it all year 'round. Machine washable. **So why wait . . . start looking great . . . order today and see!**

Measure Chest For Size.
Small: 34-38 Med: 38-40 Large: 42-44 X-Large: 46-48

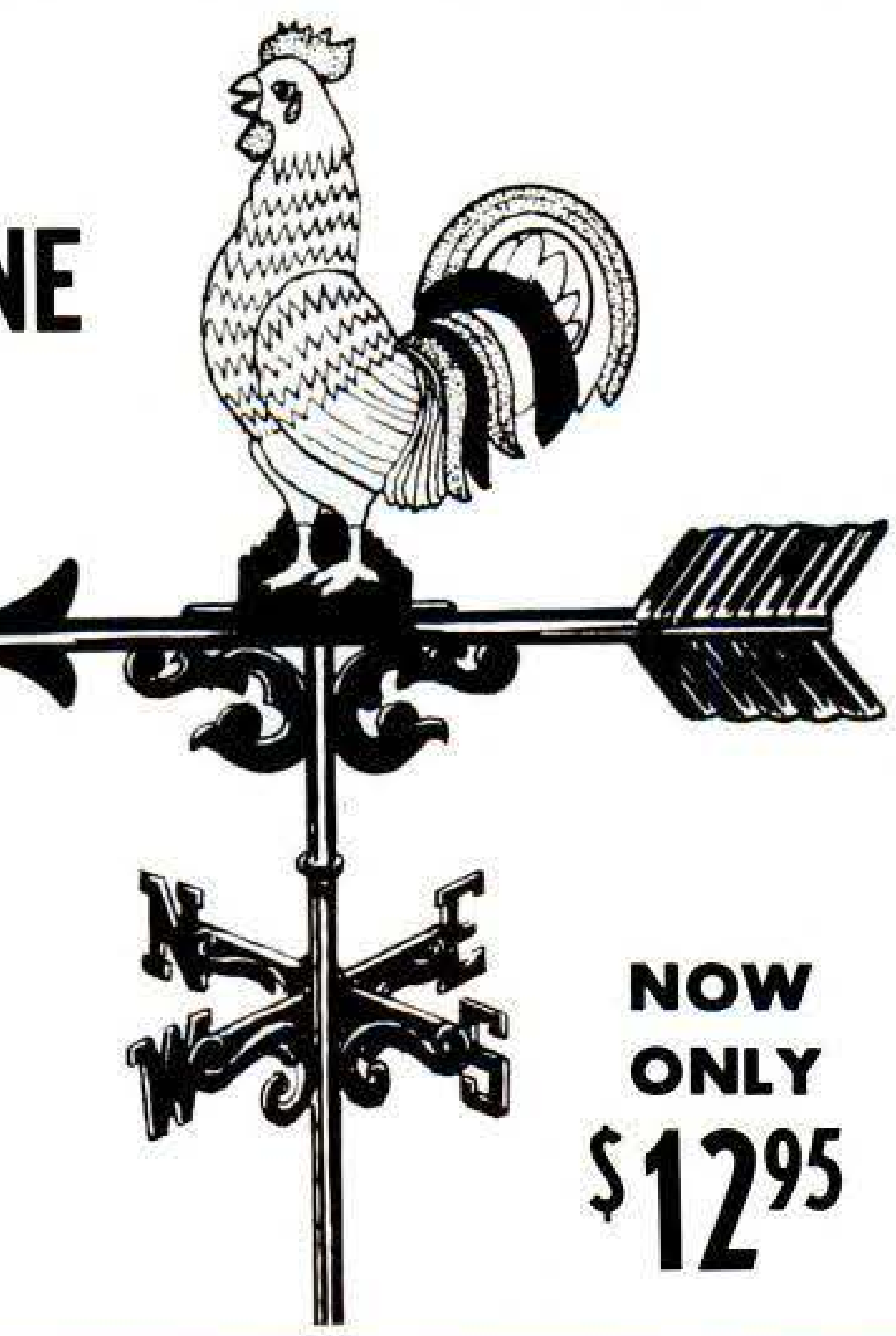
No. 2293—INSTATRIM Shirt $8.88
SAVE! Two only $15.75 — Three only $23

ALMOST 3 FEET HIGH FULL COLOR

ROOSTER WEATHERVANE

Complete Hardware Included for:

- Roof
- Porch
- Garden
- Fence
- Mail Box
- House



A "Country Classic" . . . the Rooster Weathervane. Our full color version stands **almost 3 FEET TALL** and measures 17½" across. Specially crafted for us with heavy-duty metal mounting hardware and **weatherproof** hi-impact materials. Easy to assemble hardware adapts to any angle roof. Attaches to porch, fence or mail box too. Can be mounted on pole (included) for your yard or garden . . . **it makes a charming garden accent!** And it really does work . . . tells which way the wind is blowing. Look at the price — now, that is a good **old fashioned bargain!**

NOW ONLY $12.95

No. 8143—Rooster Weathervane $12.95

Foster-Trent INC.

2345 Post Road, Dept.555-L, Larchmont, N.Y. 10538

RUSH the items ordered below on 30 DAY TRIAL — complete satisfaction GUARANTEED or my money back (except postage & handling) my payment is enclosed including $1.85 for postage & handling, (sorry no C.O.D.).

QUAN.	SIZE	ITEM NO.	DESCRIPTION	PRICE	
			SHIPPING & HANDLING	1	85
			N.Y. Residents Must Add Sales Tax		
			Total Enclosed		

For FASTER U.P.S. Delivery Use Street Address & Apt. #

Print Name ____________________

Address ________________ **Apt. #** ______

City ____________________

State ________________ **Zip** ______

PHONE SERVICE FOR VISA & MASTERCARD

☎ **Call: (914) 834-7370 Between 9:30-4:30 Eastern TIME - Minimum Phone Order $10**

Classified Opportunity Mart

Reach 4½ million readers every month with an ad in Popular Science's Classified Opportunity Mart. **DECEMBER Issue Deadline** (on sale NOVEMBER 11) is **SEPTEMBER 24.** Rates: $8.00 per word. Min. ad 10 words. Darker type (**bold**) words $1.00 per word extra. Display Classified: $445 per inch. Payment with order, or charge your Visa, MC, Amer. Exp., or Diners Club account (give # & exp.) Advertisers using box number in ad must furnish name & street address for our records. Send order & remittance. (new advertisers please submit sample with order) payable to POPULAR SCIENCE, Classified Dept. 6C, 380 Madison Avenue, New York, NY 10017.

Mary C. Ansbro, Class. Adv. Dir. Dorothy Ellis, Sr. Class. Adv. Asst.

CASIO

$39

Casio Data Bank Tele-Memo Watch • A wrist computer! Stores 50 sets of 5 letters & 12 numbers • password function • 8 digit calculator • all functions • daily alarm • stopwatch • 12/24 hour format • auto calendar • long life battery • all stainless steel chrome DBC-600 - $39. DBC-60 all black polysylfone - $29. — also have Casio's new scientific calculator watch model CFx-400 - $39. and CFx-40 scientific calculator watch - $29 • All watches Super Discount Priced!! Order now

R.B. ATHLETIC SYSTEMS
Box 1709. Lakeside. CA 92040

ORDERING INFO SEND CHECK OR MONEY ORDER WE CAN NOT TAKE CREDIT CARDS OR PHONE ORDERS AT THESE SUPER DISCOUNT PRICES ADD 2.50 POSTAGE & HANDLING FOR EACH WATCH WE GIVE YOU A 30 DAY RETURN IF NOT 100% SATISFIED AND 1 YR WARRANTY ALL PRODUCTS SENT NEW AND FACTORY FRESH SERVING YOU SINCE 1978

"R.B. ATHLETIC SYSTEMS — SERVING YOU SINCE 1978"

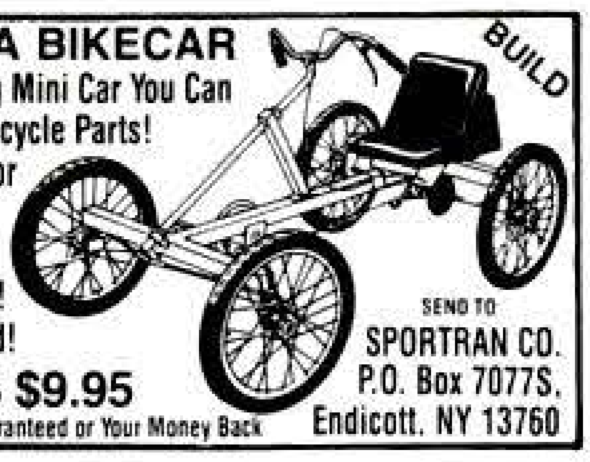
CHRISTMAS GIFTS

DISTINCTIVE GIFTS FOR ALL OCCASIONS. FREE catalog. AHA Associates, PSA1, Box 1174, Germantown, MD 20874.

KOREAN Money Sock. Wear on calf under pantleg. Eliminate bulging pockets. Protect valuables. $8.00 ppd. Friendship Trading, C.P.O. Box 6337, Seoul, Korea.

AUTOMOBILES

BUILD A BIKECAR
The Amazing Mini Car You Can Build with Bicycle Parts!
Electric Motor and Pedal Powered!
Fun to Drive!
Easy to Build!



PLANS $9.95
Satisfaction Guaranteed or Your Money Back

SEND TO
SPORTRAN CO.
P.O. Box 7077S,
Endicott, NY 13760

Like Old Cars?

Subscribe to *Hemmings Motor News*, world's largest old car marketplace. Hemmings has over 600 pages of ads each month, crammed with thousands of old cars and parts for sale. Only $16.75 for 12 giant issues. Subscribe to the 'bible' of old car collectors today. Send to:

Hemmings Motor News
Dept.1017,Box 100, Bennington, VT 05201
ORDER TOLL FREE
1-800-228-2028 (Ext 137)
(Within Nebraska dial 1-800-642-8300)
VISA/MasterCard Only

BUILD A ROLLS ROYCE IN YOUR BACKYARD!

Or Stutz Bearcat, Ford T, Jeep, Mercedes SSK, Bugatti. All 2/5Sc
Kidmans Boston Buckboard 2/3Sc.
All easy to build family fun.
12v electric Bike and scrap parts Concise plans
One car $12 Two $19 Seven $39 Brochure $2 p p
Kidmans Box 1238 A. Marblehead Ma 01945

FREE INFORMATION Starter and Alternator Rebuilding. Box 422, Syemour, TN 37865.

200,000 MILES from your auto. 36 hours annual maintenance. Manual. $5.00. **AUTORUN**, Box 142 Somerset, PA 15501.

SAVE MONEY trading cars. Plan developed over 1.25 million miles. $3.00. HG Publishing, Box 220753, Charlotte, NC 28222.

AUTO SUPPLIES & EQUIPMENT

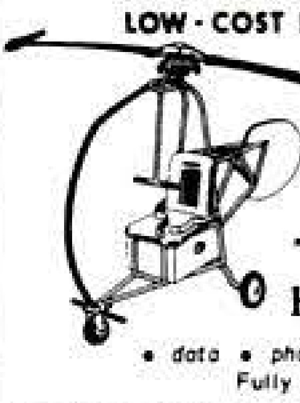
ALTERNATOR Generator Rebuilding Book. Price: Hedelund Engineering, Box 26024, Las Vegas, NV 89126.

INTRODUCING "THE NEWMATIC ENGINE ANALYZER" it allows you to quickly check several different engine functions, aids in repair of most valve train components without removing cylinder heads. **PATENTED, GUARANTEED.** Free information send Sase. A.L.C. Industries, 19827 W.12 Mi. Rd. #375, Southfield, MI 48076.

AVIATION

BOOMERANGS — INCREDIBLE RETURNS! Unique sport. Exciting hobby. **FREE** 10th Anniversary Catalog. World's best! BoomerangMan, 1806-2 N.3rd., Monroe, LA 71201-4222

The Homebuilt
JET HELICOPTER
LOW-COST DESIGN — SIMPLIFIED ASSEMBLY



• Uses low-cost fuel
• No license needed

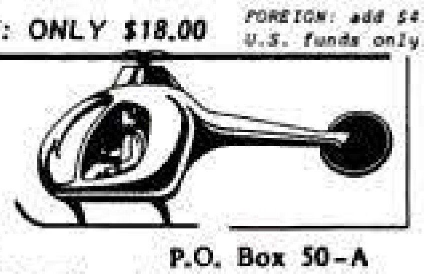
CONSTRUCTION MANUAL
— Fully illustrated —
Only $11.00*

THE
Helicopter Experimenter's HANDBOOK
• data • photos • designs • suppliers
Fully illus. Only $10.00*

*BOTH ABOVE BOOKS: ONLY $18.00

FOREIGN: add $4. U.S. funds only.

NEW!
An exciting
Kit Helicopter!
Details sent with
book orders.



Plans/accessory information: $3 or FREE with $18 order!

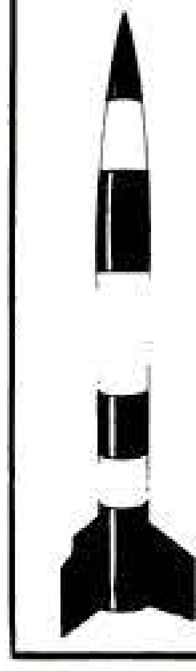
HELICRAFT Inc. est. 1970

P.O. Box 50-A
Riderwood, MD 21139
U.S.A.

ASTRONAUTICS

ANTIGRAVITY — PARANORMAL — ENERGY. Information Package $2.00. **HEER,** Box 5286, Springfield, VA 22150.

NASA anti gravity device. Patent disclosure. $4.50. Cetar, POB 2252-A, Coeur d'Alene, ID 83814.



BUILD YOUR OWN ROCKET MOTORS!
- * 40 POUNDS THRUST!
- * FIFTY CENTS EACH!
- * BUILD A DOZEN IN AN EVENING!

Write for our brochure,and we'll send you a WORKING SAMPLE of an electric igniter that YOU CAN MAKE YOURSELF from materials you'll find around the house.

Send $2.00 to:
Dept. PS10 THE TELEFLITE CORPORATION.
11620 Kitching St., Sunnymead, Calif. 92388

NASA emblems, toys, gifts, collectibles. Catalog $1.25. Refundable. Collector Trends, Box 361-P, Dayton, OH 45409.

ROBOT Unique Hi-Tech conversation piece! Brochure $1.00. Box 19388, Austin, TX 78760.

A MAGAZINE that keeps you up on space flights worldwide. $14.00 for 12 issues. **SPACE ADVENTURER,** Box 352, Lake Park, GA 31636.

KITES

KITES

FREE COLOR CATALOG
Choose from over 100 kites.
Many unusual & innovative kinds.
Call or write for your catalog today!
Into The Wind • (303) 449-5356
2047-P Broadway, Boulder, CO 80302

HOVERCRAFT

HOVERCRAFT Plans, Parts. Catalog $1.00. Universal, Box 281, Cordova, IL 61242.

AERO-CAR Amazing Hovercraft built easily with ordinary tools. Lawnmower engine powered. Carries one man plus. Flies over land/snow/water. Complete plans and booklet. $10.95. Aero-Projects, Box 5118PS, Clinton, NJ 08809.

HOVERCRAFT plans. 7 to 80 horsepower. Information $2.00. Sevtec, P.O. Box 846S, Monroe, WA 98272.

ALTERNATE ENERGY

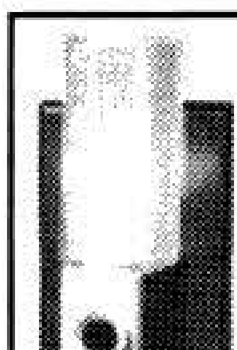
TESLA, FREE ENERGY, ETC. New technical publications. Tesla Book Co., 1580 Magnolia, Millbrae, CA 94030.

FREE Energy Generator. $9.50 plans. French Research, 621-E South 3rd, Walla Walla, WA 99362.

PHOTOVOLTAIC battery charge controller. Priced right. Free details. Danocinths Inc., Dept-PS, Box 261, Westland, MI 48185.

200 EXOTIC ENERGY INVENTIONS, Rare Technical Data. Astounding 40-page Catalog, $2. Rexsearch, Box 1258, Berkeley, CA 94704.

ENERGY SAVING



Automatic on at dusk, off at dawn nightlight. 4½" × 1½" with plug-in for any standard wall outlet, save energy, provide security, UL listed. $5.95 postpaid. Satisfaction guaranteed! **Mannix Trading Co. Dept. PS 39 Bowery, New York, NY. 10002**

HOME CRAFTSMAN

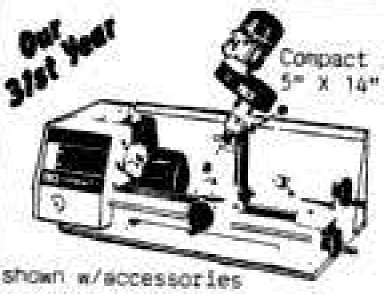
DOES YOUR SUMP PUMP WORK during power failure - Ours Does - without a plumber. Catalog $1.00 Refundable. Residential Safety Systems Inc., 600 Cross St., Bldg. A, Lakewood, NJ 08701.

MAKE PVC PIPE FURNITURE Many proven plans. Profitable home business. Free Details J&L Casual Furniture, Box 208P, Tewksbury, MA 01876.

STEAM ENGINE KITS, Power models at savings to you! Send $1.00 for literature. P.M. Research Inc., Dept. 5, Rd #2, Box 29, Wellsville, NY 14895.

MAKE WOODEN TOYS, whirligigs, classic autos, swing sets, doll houses, crafts, furniture with our plans, parts, kits, supplies. Color catalog subscription $1. (614) 484-4363. Cherry Tree Toys, Belmont, OH 43718-0369.

TOOLS & MACHINERY



LATHES
·$279 & Up
·Precision Tools
·Machinery
·Metals
$1.00 Catalog
513-322-8562
CAMPBELL TOOLS COMPANY
2100P Selma Rd., Springfield, Ohio 45505

AMAZING PAINT SAVER!

Latest Tool For The Painter
Stop messy overflow! Use less paint! Maintain the correct amount of paint on your brush each time! Order today!
1-$5.95, 2-$9.95 Plus shp & hndl
1-800-826-8870 (IL 618-594-2533)
CARLYLE PRODUCTS
Carlyle, Illinois 62231

4" METAL Cutting Lathe $104.50. Taig, 15048 Proctor, Industry, CA 91746.

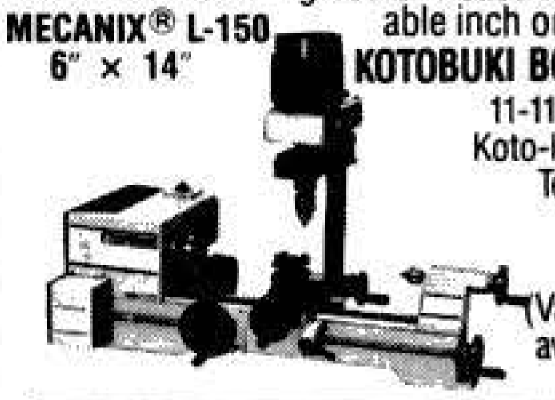
SMALL FOUNDRY Furnace. Supplies. Free Literature. Pyramid Products, Dept. M, 3736 South 7th Avenue, Phoenix, AZ 85041.

"SHARPENERS REPORT" Monthly Newsletter. Sharpening Guidebook, Angle Wall Chart, Free details. Skog Company, Dept. PS10, P.O. 22559, Minneapolis, MN 55422.

BOLTS, SCREWS, TOOLS. WHOLESALE, DIRECT. Guaranteed. Catalog $1.00 (refundable). Camelot, Dept. 33, Box 65, Bristol, Wisconsin 53104.

UNIVERSAL MACHINE TOOL
MECANIX® L-150
6" × 14"

For work shops and hobby engineers. Reasonable price. Available inch or metric version.
KOTOBUKI BOEKI COMPANY
11-11, Saga 1 chome,
Koto-ku, Tokyo, Japan
Telex: 0-252-3476
KBKK J



(Vacancies of agent available in several districts)

LATHES – MILLING MACHINES
MACHINE SHOP SUPPLIES – TOOLS

BLUE RIDGE
MACHINERY AND TOOLS, INC.

Catalogs $1.00 (over 200 pages)
Toll Free Number For Orders
PO Box 536-P Hurricane, WV 25526
REPRESENTATIVES OF MANY MANUFACTURES
304-562-3538

GIANT Home Workshop Specification **GUIDE. ONLY** 25¢ ! **DHI,** 9443 Deerwood, Osseo, MN 55369.

PLANS, BLUEPRINTS

AUTHENTIC BUTCHER BLOCK TABLES. Plans $5.00. 8129 Bullneck, Baltimore, MD 21222.

NUCLEAR RADIATION? SURVIVE! Build detector with household materials. 13 page detailed instructions $5.00. Collectors, Box 215, Allentown, PA 18105.

BURGLAR/FIRE ALARMS

ELECTRONIC DEFENSE stuns and disorients attackers. Send S.A.S.E. for more information. Cameo Enterprises, P.O. Box 63, Accord, MA 02018.

LOTTERIES

WIN MILLIONS in Canadian lotteries. ree details plus **FREE TICKET OFFER.** ucky Buck (PS), Box 171, Station W, oronto, Ontario, Canada M6M 4Z2.

DO IT YOURSELF

HYDROGEN AUTO FUEL FROM WATER. Amazing Free Report. Merit, Box 363, Louisville, KY 40205.

APPLIANCE REPAIR — Illustrated ow-To book shows easy volt/ohmmeter roblem checks, washers, dryers, refrigerators. Free details, DLRP, 713 Silvertone, ichardson, TX 75080D.

VAN de GRAAFF GENERATOR 50,000 Volts of Electrostatic Energy. xperiments. Lightning, Truly "HairRaisng" Free Details. Associated Scientific, ox 15098, San Diego, CA 92115.

4 EASY STEPS to Professional Carpet nstallation Complete with photos and diagrams. Send $9.95 for booklet. ACV Enterrises, P.O. Box 5365, Bloomington, IN.

VOICE Disguiser, FM Transmitter, Telehone Transmitter and More! Send tamped envelope: Xandi, Box 25647, empe AZ 85282.

4321 CATALOGS listed. Sources For nything! $5.00 Catalogs. Box 92452X, tlanta, GA 30314.

CHAINS ON PORCH SWING SQUEEK? Send $3.00, special bearing kit. **SWINGBIRGS,** Box 640-PS, Loreauville, A 70552.

SYNCHRONIZE YOUR CHRISTMAS DISPLAY, make it more impressive. Write: isplay, Box 2035, Inver Grove, MN 55075.

PROJECTION TV... Convert your TV to roject 7 Foot picture... Results comparable o $2,500 projectors... Total cost less than 30.00... Plans and 8" Lens $21.95... Illusrated information **FREE.** Macrocoma-ab, Washington Crossing, Pennsylvania 8977. Creditcard orders 24HRS. (215) 736-979.

ELECTROPLATING. Complete Textook. Electroplate Metallics/Nonmetalics. $11.95. Details Free. Tropic, Palm Bay, L 32906-0095.

FIBER-OPTICS: Ten feet of 20 mil, high uality, continuous strand. $1 plus SASE. andikits, Box 143, Hatboro, PA 19040.

COTTON CANDY MACHINE! Build your wn for under $75! Information pack $1.00. yclone Manufacturing, Box 285, Midvale, T 84047.

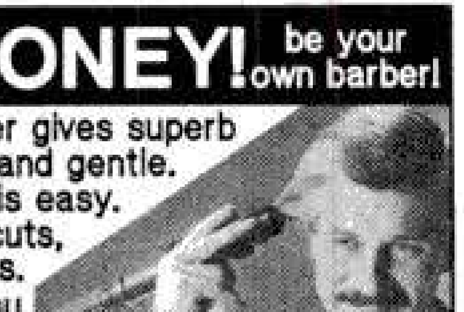
I SAVED $4,000 SELLING MY OWN HOME. You may save thousands in real state fees, too! We supply practical Do-It-ourself Manuals and sign kits. Free Infornation. Resource Link, Dept-PS, Box 1735, es Moines, IA 50306.

SUN-LITE GREENHOUSE/SUNSPACE. It's the MOST HIGHLY INSULATED, IGHT TRANSMITTING greenhouse anyhere. It lets diffused sunlight in. ARMER in Winter. COOLER in Sumer. Perfect for people and plants. Lean-to r Free-standing. Easy-do-it-yourself kit tarting at $1995. No foundation needed. arranteed. Free literature including our 4 page Solar Products Catalog. Solar omponents. Dept 94-G, Box 237, Manhester, NH 03105.

MIX-UP Cement, Mortar, Soil, Feed, rain, Chemicals, etc. with the brand new 2 cu.ft. Mix-Mate all purpose **HAND OWERED MIXER.** Ideal for homeowners, mall trades, gardeners, farmers. Thouands of uses. **FREE BROCHURE.** B.K.S., ox 621, West Caldwell NJ 07007.

BUILD YOUR OWN SATELLITE DISH NTENNA. Book Provides Pictures, Illusations, Easy To Follow Instructions for)-½ft Dish Antenna. Send $12.00. Power ain Systems, Dept B, P.O. Box 2955, West onroe, LA 71291.

SAVE MONEY! be your own barber!



ew Auto-Haircutter gives superb aircuts easy, fast and gentle. ven back of head is easy. easures length, cuts, apers, collects clips. ll automatically, you ust pass it over hair. o blade changing either. Uses SkilTwist driver. ake extra money! Cut hair in your sparetime! et fresh haircut in minutes, easy as combing, ften as you like. You'll look better, feel better. Free Haircut Guide included with every order. atent pend. Use our haircutter for 60 days. not delighted, get immediate full cash refund. ree info. Mail today $16.95 for haircutter to: obocut Co.7, POB 9713, Ft.Collins, Co 80525

MICRO BUGS

Highly advanced bugging equipment. Ultra-small transmitters, concrete mics, telephone, pen bugs and much more. Send $2.00 to **MICROCOM** for catalog (REFUNDABLE). Unbeatable prices.

½ MILE RANGE **MICROCOM TECHNOLOGY**
Dept. -D5 • P.O. Box 347341 • Cleveland, OH 44134

AMAZING SCIENTIFIC and ELECTRONIC DEVICES

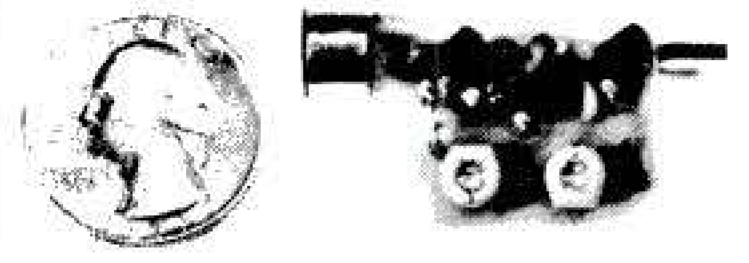
PLANS — All Parts Available in Stock
- LC5 BURNING CUTTING CO2 LASER $20.00
- RUB3 RUBY LASER RAY PISTOL 20.00
- BTC5 1.5 MILLION VOLT TESLA COIL.....15.00
- PTG1 PLASMA TORNADO GENERATOR...10.00
- GRA1—GRAVITY GENERATOR.....................10.00
- MAGNETIC CANNON/PROJECTOR...............10.00

KITS — Includes Plans and Parts
- LHC2K SIMULATED RED/GRN/YEL LIGHT LASER..34.50
- BTC3K 250,000 VOLT TESLA COIL........159.50
- IOG1K ION RAY GUN.........................109.50
- PSP3K PHASOR SHOCK WAVE PISTOL ..49.50
- INF1K INFINITY TRANSMITTER...........134.50
- MFT1K 2-3 MILE RANGE FM VOICE XMTR PC BOARD 49.50

ASSEMBLED AND TESTED PRODUCTS
- LGU30 RED 1MW PORTABLE HENE LASER 349.50
- TCL30 SOLID STATE TESLA COIL 35KV..84.50
- IPG50 POCKET PAIN FIELD GENERATOR.64.50
- BLS10 BLASTER DEFENSE WEAPON 89.50
- PPF10 PHASOR PAIN FIELD PORTABLE 249.50
- SNP20 SECURITY PHONE LISTENER 99.50
- **CATALOG** CONTAINING DESCRIPTIONS OF ABOVE PLUS **HUNDREDS** MORE AVAILABLE FOR $1.00 OR INCLUDED **FREE** WITH ALL ABOVE ORDERS.

PLEASE INCLUDE $3.00 PH ON ALL KITS AND PRODUCTS. PLANS ARE POSTAGE PAID. SEND CHECK, MO, VISA, MC TO:

INFORMATION UNLIMITED
P.O. BOX 716, DEPT. P8 AMHERST, NH 03031



PICKS UP A WHISPER 50 FEET AWAY

The model WAT-50 miniature FM transmitter uses a 4-stage circuit NOT to be confused with a simple wireless microphone. Simply snap the unit on top of a 9V battery and you can hear every sound in an entire house up to 1 mile away! Use with any FM radio. Tunes to any frequency from 70mhz—130mhz. Easy to assemble kit includes all parts and instructions. Only $29.99 tax incl.

Call or send MO, VISA, MC for immediate delivery. Include $1.50 S&H. FREE SHIPPING on orders of 2 or more. All orders shipped by U.S. Mail. COD add $4.00. Personal checks allow 21 days.

DECO INDUSTRIES
BOX 607
BEDFORD HILLS, NY 10507
914-232-3878

SUPPRESSED INVENTIONS **PARADOX SCIENCE**

Free Energy & Anti-Gravity! Alchemy! Physix Anomalies! 200 Topics, Rare Info, Plans! Amazing 40-Page Catalog!!! Send $2:

INFOLIOS
Box 1258, Berkeley, CA 94701

LASER

LASER OR MASER PISTOL — COMPLETE
Plans for Building—$5.00 each
P-Rod—$16.00
INVISIBLE FORCE FIELD—$4.00 MOON MAN ROBOT—$4.00
SOUND LASER $4.00
Ion Aeronautical Lift System $7.50
Real Ruby Crystal ¼" - 2" for educational use $350.00
High Power CO_2 Laser $7.50
Catalog of super Science Projects—$1.00

JACK FORD SCIENCE PROJECTS
PO Box 1009, Duluth, GA 30136

AN OFFER YOU CAN'T REFUSE

If you're an above average do-it-yourselfer planning a major home improvement project, you may qualify for savings on the cost of many building materials needed for your project.

Send us a detailed description of the project, together with a materials list. If your project is selected, we'll help offset the cost of the building materials you need (up to an agreed upon amount) in exchange for publication rights to articles about your project. Projects already in the works are not eligible.

Send your project description and materials list, preferably with drawings, to:

Home Projects
P.O. Box 5429, New York, NY 10163.

Do not send original materials; they cannot be returned. The deadline for entries is December 15, 1986.

TELEPHONE LISTENING DEVICE

Record telephone conversations in your office or home. Connects between any cassette or tape recorder and your telephone line. Starts automatically when phone is answered. Records both sides of conversation. Stops recorder when phone is hung up.

SIZE 1 cu. in.

$19.95 EACH Qty Disc Avail

Super Powerful FM TRANSMITTER

Many times more powerful than other transmitters. Transmits up to ¼ mile to any FM radio -Easy to Assemble Kit - up to 9V battery (not incl.)

For catalog of Transmitters, Voice Scramblers and other specialty items, enclose $2.00 to USI Corp.

Call 305-725-1000 or send $19.95 + $1.00 shipping per item to: USI Corp., PO Box PS-2052, Melbourne, FL 32902 COD's OK. 1×1⅜"

BOATS, INBOARD/OUTBOARD MOTORS

BOAT Plans — Patterns — Kits — Hundreds of designs — Sailboats — Powerboats — Sportsfishers — Rowboats — Duckboats — Bassboats — Canoes — Hydroplanes — Simple construction — Proven results — Tremendous savings! Gigantic 160-page catalog $3.00 ($4.00 Airmail) — Includes Free "Boatbuilding Supplies" catalog. GLEN-L. 9152 Rosecrans, Box 756SP, Bellflower, CA 90706.

BOATS KITS—SAIL—16'-30' all trailerable molded fiberglass hulls and decks come factory assembled—you install factory supplied interior. Save half factory built cost. No experience required. **FREE** 40 page catalog. **LUGER,** Dept. AC-106, P.O. Box 1398, St. Joseph, MO 64502. 1 (800) Boat Kit, MO: (816) 233-5116.

More Boat ads on next page

REAL ESTATE

CANADIAN COUNTRY PROPERTIES. Acreages for recreation, development, farming, fishing, hunting, investment, minerals, etc. **OUR 71ST YEAR.** Terms available. Titles guaranteed. Catalog airmailed $1.00. **DIGNAM** Corporation, Suite 481, 85 Bloor Street East, Toronto, Canada, M4W 1B5.

CALIFORNIA. Acreage. Lots. $40 down. 40 monthly. 4602 Ethel, Sherman Oaks, CA 91423.

GOVERNMENT HOMES From $1.00. You Repair. Also Delinquent Tax Property and Foreclosure Lists. For Information Call Refundable 1-312-888-0123 X-H-504.

MONTANA LAND

20 Acres (or more) starting at $6950 with $150. down, $96.58 mo. Near Beautiful Yellowstone Park and National Forests. In the heart of trophy elk, deer, moose, antelope and turkey hunting. Blue ribbon trout streams. Guaranteed Access. INSURED TITLE AND WARRANTY DEED. Your Inspection Welcomed. Free Color Brochure. Video Tapes Available.

Call Today TOLL FREE: 1-800-252-5263
Yellowstone Basin Properties
1119 N. 7th Ave., Dept. PS, P.O. Box 3027
Bozeman, MT 59772-3027 • (406) 587-5469

ARKANSAS Homes, Farms, Land. Free List. American Real Estate, 71 North, Mena, AR 71953.

EARN to $10,000 month or more Buying Nationwide Real Estate at 30%-40% Below Market - consistently. No competition. No license or experience necessary. Probate & Financially distressed property. No Cash Down/No Credit Necessary. Thousands of opportunities exist. 216-453-3000, Ext. K8085

150 TOP MANUFACTURERS OF FACTORY HOUSES THAT YOU CAN BUILD YOURSELF! Save up to 40%. Send $1.00. Building Institute PS10, Piermont Ave., Piermont, NY 10968.

FREEDOM COUNTRY

20 BIG acres in **WESTERN MONTANA,** starting at $9850 . . . $200 down, $114/month. Trout fishing, backpacking, camping. Elk, deer, moose, bear. **ADJACENT** to National Forests, near established towns. Yellowstone and Glacier National Parks nearby. **GUARANTEED ACCESS, INSURED TITLE, WARRANTY DEED.** FREE color brochure, photos, maps. **FULL MONEY-BACK GUARANTEE.**

CALL TOLL FREE 1-800-592-5990.
TREASURE STATE RANCHES
210 Milwaukee Street, Dept. PS
Deer Lodge, Montana 59722 - (406) 846-1000.

Real Estate — Call STROUT Free!

All Across America — Homes, Businesses, Rec Land

Strout Realty & Strout American Realty

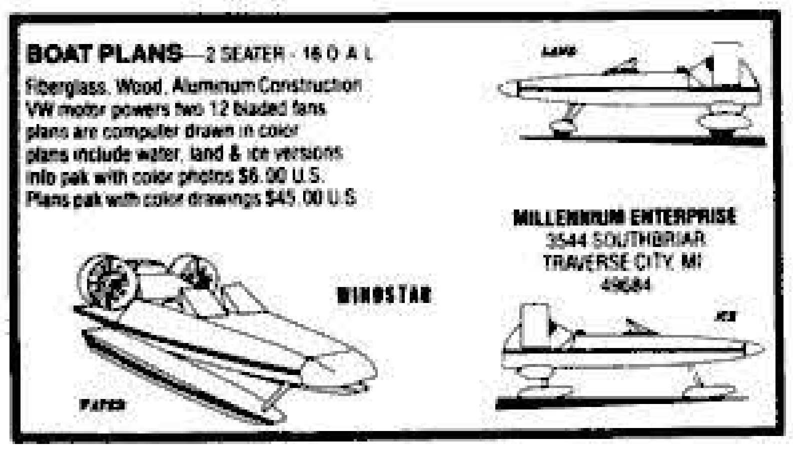
Andalusia, AL 1-800-222-4431
Scottsdale, AZ 1-800-872-5263
Hot Springs, AR 1-800-258-5263
Mena, AR 1-800-872-6362
Redding, CA 1-800-225-7767
or 1-800-247-7337(CA)
Selma, CA 1-800-323-9955(CA)
Spg Valley, CA 1-800-523-3369
Upland, CA 1-800-843-8389
or 1-800-843-8158(CA)
Yreka, CA 1-800-392-1616
or 1-800-547-2288(CA)
Cederedge, CO 1-800-551-5598
Cortez, CO 1-800-592-2828
Blountstown, FL 1-800-222-3919
Cape Coral, FL 1-800-872-4853
Miami, FL 1-800-423-6747
Blairsville, GA 1-800-368-5263
Bloomfield, IN 1-800-582-8130
Dixfield, ME 1-800-367-7710
Howland, ME 1-800-225-9025
Skowhegan, ME 1-800-237-2027
Troy, ME 1-800-258-8769
Berlin, MD 1-800-641-5263
Baudette, MN 1-800-626-1257
Bagnell Dam, MO 1-800-334-3011
or 1-800-292-4414(MO)
Branson, MO 1-800-872-8439
or 1-800-422-5117(MO)
Camdenton, MO 1-800-872-8770
or 1-800-392-9966(MO)
Cassville, MO 1-800-423-6284
Edina, MO 1-800-545-2236
El Do Spgs, MO 1-800-231-3998
Hartville, MO 1-800-327-7253
Osage Beach, MO 1-800-862-5253
or 1-800-831-2011(MO)
Osceola, MO 1-800-522-7639
Stockton, MO 1-800-872-5253
West Plains, MO 1-800-992-0214
Lincoln, NH 1-800-343-4589
Clovis, NM 1-800-334-8719
Taos, NM 1-800-552-0070;ext 837
Auburn, NY 1-800-535-0018
Binghamton, NY 1-800-624-9891
or 1-800-551-5508(NY)
Carthage, NY 1-800-237-3786
Cincinnatus, NY 1-800-322-2067
Cooperstown, NY 1-800-225-3219
Essex, NY 1-800-835-8306
Fredonia, NY 1-800-544-7253
Gouverneur, NY 1-800-872-2021
Kerhonkson, NY 1-800-225-6662
LaFargeville, NY 1-800-872-3315
Malone, NY 1-800-835-8304
Massena, NY 1-800-345-5456
Mayville, NY 1-800-872-2270
Potsdam, NY 1-800-338-5263
Redwood, NY 1-800-654-3489
Wellsville, NY 1-800-642-3338
Woodsfield, OH 1-800-227-6461
Ashland, OR 1-800-225-2773
Cave Junction, OR 1-800-331-7784
Klamath Falls, OR 1-800-523-5586
Bentley Creek, PA 1-800-872-6789
Bradford, PA 1-800-223-4390
Lehighton, PA 1-800-874-7253
Montrose, PA 1-800-321-2249
Pennsdale, PA 1-800-872-2011
Sandy Lake, PA 1-800-227-5647
Susquehanna, PA 1-800-237-8018
Conroe, TX 1-800-325-3144; 222#
Appomattox, VA 1-800-523-9881
or 1-800-468-3345(VA)
Dillwyn, VA 1-800-641-7374
Chehalis, WA 1-800-225-6907
Keyser, WV 1-800-445-5263
Marlinton, WV 1-800-982-5263
Peterstown, WV 1-800-233-8385
Briggsville, WI 1-800-872-2744
Kewaunee, WI 1-800-828-2355
Richland Ctr, WI 1-800-647-0015
Powell, WY 1-800-826-0381

Or call 1-800-555-1212; ask for **STROUT REALTY & STROUT AMERICAN REALTY, any city** USA. Or 1-800-641-4266. (Strout #6270, Box 4528, Spgfld, MO 65808. **Indicate type of** property, state(s) of interest.)

BOATS, (cont.)

BOAT KITS - PLANS - PATTERNS - FRAME KITS - 200 Designs-40th year-8'/80' - Plywood - Fiberglass - Steel - **POWERBOATS** - Cruisers - Houseboats - Hydroplanes - Runabouts - Duckboats (Canoe Kayaks) - **SAILBOATS** - Daysailers - Trailersailers - Multihulls - SUPPLIES - Epoxies - Polyesters - Cloth - Foam - **CATALOGUE** $3.00 (Airmail $5.00) (Book Amateur Boatbuilding $6.75) **Clarkcraft** 16-S Aqualane, Tonawanda, NY 14150.

EVINRUDE—OTHER BRANDS 1985 BARGAINS...All Sizes...$2.00 Handling. Scott McCulloch parts...Electra Marine, 610 Merrick Road, Lynbrook, New York 11563.



BOAT PLANS—2 SEATER - 16 O A L
Fiberglass, Wood, Aluminum Construction
VW motor powers two 12 bladed fans
plans are computer drawn in color
plans include water, land & ice versions
info pak with color photos $6.00 U.S.
Plans pak with color drawings $45.00 U.S.

MILLENNIUM ENTERPRISE
3544 SOUTHBRIAR
TRAVERSE CITY, MI
49684

BUSINESS OPPORTUNITIES

NEW Discovery in Battery reconditioning. Eighteen months guarantee! Means Big Profits Fast! Electoan, 7415 Gable Dr. Little Rock, AR 72205.

CONCRETE Block Machinery: Catalog $1.00. Route One, Box 3740, Rapid City, South Dakota 57702-3740.

IMPORT-Export opportunity, profitable world-wide, mail order business from home, without capital. We ship plan for no risk examination. Experience unnecessary. Free Report. Mellinger, Dept. C2699, Woodland Hills, California 91367.

BORROW $300-$30,000 Worry Free! Keep Indefinitely! Free Details! Write: American, 1601 Main, Plainfield, IN 46168.

BUMPER Sticker Printer. Cheap, Simple, Portable. Free details Bumper, POB 22791(LLC), Tampa, FL 33622.

LEARN MIRROR RESILVERING, Free Information. Silvercraft, Box 127, Lansdowne, PA 19050.

ALUMINUM SCRAP-Recycle Yourself-**MAKE $25.00/POUND!** Free Information: Industrial-PS610, Box 127, Alexandria Bay, NY 13607.

REPAIR HYDRAULIC JACKS—Free details. Hydraulic Parts Supply, Dept. S, Box 4157, Brownsville, TX 78520.

RECYCLE METALS. NO, NOT BEER CANS! Easy $458 weekly! Free information, Hornsby's, Box 1214, Franklin, TN 37065-1214.

HUGE PROFITS! Reconditioning used car batteries. Secrets others don't tell. Stamp please. Battery Outlet, Box 3300, Hickory, NC 28603.

MAKE HOMEMADE BOOKLETS. I'VE EARNED $187,000 **WITH MINE. MONEY NEVER STOPS!** Free information: Dasher, P.O. Box 1039, Gatlinburg, TN 37738.

MECHANICALLY inclined individuals desiring High Weekly Profits operating Small Manufacturing business Without Investment write: Businesses, 92-P Brighton 11th, Brooklyn, NY 11235.

$192.00 FROM Square Foot Plywood (Huge Demand), Revealing Proof 50¢ (Refundable), Woodwins, Bridgewater, MA 02324.

$40,000 ON 1/3 ACRE! New hydroponics—inexpensive, pleasant, practical! Free information. Planter's, Box 1214, Franklin, TN 37065-1214.

SPARE time fortune in Vinyl Repair. Huge demand creates exceptional profits. We supply everything. Details free. VIP, 2036 Montrose, Chicago 60618.

GOLD Stamping Machines. Inexpensive. Quality. Large imprint Area. Free details. Magic Systems, POB 24986 (LLC), Tampa FL 33623.

MAKE Rubber Stamps. Highly Profitable Business. Free Details. Stamper, POB 22809 (LLC), Tampa FL 33622.

TAKE Catalog Orders. We drop-ship 2955 best-selling specialty products. Lowest below wholesale prices. Immediate delivery. Spectacular home business opportunity. Free Book. SMC, 9401 De Soto Ave., Dept. 28-70, Chatsworth, CA 91311–4991.

FREE! TREASURY OF HOME BUSINESS OPPORTUNITIES, POPCO, BOX 34370, BARTLETT, TN 38134-0370.

$1,000 weekly mailorder. Immediate opportunity. No obligation. Enterprise, 210 Welch-PS, Ames, IA 50010.

SCREEN Print T-Shorts. Inexpensive kits. Free Details. "T-Printer." POB 23991 (LLC), Tampa, FL 33623.

YOU Can Make Money Wholesaling. Free Details. Brokerage, Box 230187, Montgomery, AL 36123.

MAKE BIG MONEY REPAIRING WINDSHIELDS, & Plate Glass! Up to $60,000 yearly! Call **TOLL-FREE** for Valuable **FREE** report. **1-800-321-2597.** Glas-Weld Systems, Box 5755-C10, Bend, OR 97708.

$25,000 LOANS INTEREST FREE! Secret Federal law **WIPES OUT PESTS!!** Details **FREE!!** Moneywise-S, Box 26744, Tamarac, FL 33320.

GET RICH using **OTHER PEOPLE' MONEY!!** Unique—amazing business! Details **FREE!** Finance-S, Box 4605, Margate, FL 33063.

GET RICH !! Secret law smashes debts—brings cash credit! Details **FREE!!** Wealth-Kit-S, Box 4036, Pompano, FL 33063.

FREE! Get listed, Receive (1000's) the Hottest Business Opportunities. Nonstop. Listing, Box 4222, Rockford, IL 61110.

SELL HOW-TO BOOKS BY MAIL

UP To 2000% PROFITS

START NOW!

We drop shipped at very low prices, books, cassette tapes, manuals and reports. Beautiful illustrated catalogs, circulars and sale aides supplied for your mail order sales. Start without capital! One of the fastest Money Making in mail order industry. Complete details and catalogs. Send $1.00 for postage (refundable) to:

LONG PUBLISHING, Dept. P-27
P.O. Box 1465, Garden Grove, CA 92642-1465

$1,000'S WEEKLY

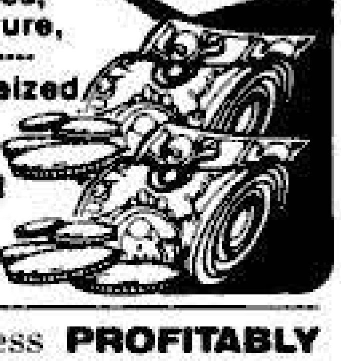
Home Business Directory
Exciting free details. Write:
Box 2019-PS
New York, N.Y. 10163

$5,000 MONTHLY Guaranteed! New Home Mailing Program Guaranteed Earnings. Start Immediately. Details Write: LBI Systems, Dept. PS. Box 3430, Jamaica, NY 11432.

14,947 HONG KONG, Taiwan **PRODUCTS CHEAP** Small lots. Some samples free. Harbor, Box 1719-PS10, Yuba City, CA 95992.

GOVERNMENT SEIZED PROPERTY Could Make You RICH!

LITTLE-KNOWN SECRET REVEALED!
Buy Dirt Cheap - Automobiles, Trucks, Vans, Boats, Furniture, Stereos, Appliances & TVs ---- thousands of other items seized in narcotics raids —
Resell at Big Profits!
Free Information!
Write Today!
MARCEL Dept. EB
P.O. Box 7557
Monroe, LA 71211



MANAGE Any Business **PROFITABLY** Guide $8.95. DJM, Box 1657-PS, Perris, CA 92370 - Calif. add tax.

LEARN Piano Tuning. Big Profits! Empire School, Box 1014PS, Jupiter, FL 33468-1014.

HIGH Profits With Custom T-shirts And Caps. Inexpensive, professional heat transfer machines. All supplies. Press Magic, P.O. Box 22809, (LLC), Tampa, FL 33623.

AMAZING Fortune hidden in "junked" batteries. Take it for pennies! 17 years Success Secrets yours now. Write: OwenCo, 771 PS, Battle Ground, WA 98604.

MONEY—MONEY—MONEY
Send now for free details on how to make more money than you ever dreamed of! Tycoon Books, 4009 Pacific Coast Highway, Torrance, CA 90505.

LEARN Sewing Machine Repairing. Men, Women, Lucrative Profits. Gresslin Correspondence School, Box 5104, Spencer, IA 51301-0804.

MAKE PVC Furniture. Turn your spare hours into $31,200 yearly! Easy home assembly business. Write: PVC, 771PS, Battle Ground, WA 98604.

MAKE $20,000 yearly cleaning restaurant duckworks. Easy 8 hours weekly. Untapped marketplace needs you now! Details: Ductworks, 771 PS, Battle Ground, WA 98604.

$500. WEEKLY Recycling Discarded Tires! Stamp Appreciated. La Vallees, Fountain, FL 32438.

NEVER OFFERED BEFORE Highly profitable business. Every automobile owner potential customer. Complete details $5.00. (Refundable) Magnolia Associates, Box 1184PS, Yazoo City, MS 39194.

AMAZING Profits! Sell wholesale retail mail-order. Any quantity: Jewelry, Giftware, Toys, More. $3.00 (refundable) bring Giant Catalog Confidential price list. Cloud, 231-32S Merrick Blvd., Laurelton, NY 11413.

JOINT-VENTURE MANUFACTURER WANTED for development and mass-production of GIROCYCLE. PRES, PO Box 306, Queens, NY 11372. 718-424-3993.

INCREDIBLE Income! Sell information by mail. Details: MCPI-S1, 231-32 Merrick Blvd., Laurelton, NY 11413.

$3,000 MONTHLY Information Business Brings. Venture-S, Box 10179, Alexandria, VA 22310.

PROJECTION TV... Make $$$'s assembling Projectors... Easy... Results comparable to $2,500 projectors... Total cost less than $30.00... **PLANS, 8" LENS** & Dealers Information $20.50... Illustrated information **FREE**... Macrocoma-abx, Washington Crossing, Pennsylvania 18977. Creditcard orders 24HRS. (215) 736-2880.

START Your Own Big Money, Easy Home Book Business! Free Details, Rey. 12841 Hawthorne Blvd., #117M, Hawthrone, CA 90250.

$1,000'S MONTHLY!!! Seven most profitable home businesses. Easy how-to instructions. Free information. Marcliff, 13110 Patuxent, Dept. PS1086, Baltimore, MD 21220.

FINANCIAL FREEDOM! START YOUR OWN PROFITABLE BUSINESS. FREE DETAILS! PUBLISHERS, BOX 720770, HOUSTON, TX 77272.

HOW TO start your own profitable business at home. Free details. MPM Publishing, 513 Greenwood Ave., Clarks Summit, PA 18411-1415.

WANTED—Pickup truck owners that need $1,000 additional income. Free details. Kingston, Dept6E, Oskaloosa, KS 66066-9028.

UNIQUE MONEY MAKERS!! Unusual business ventures revealed! Details Free! Franklin Place, 13990 Valley View, Red Bluff, CA 96080.

MAILORDER Opportunity: Start profitable home business without experience or capital. Information Free. Mail Order Associates, Dept. 573, Montvale, NJ 07645.

HOW To Start and Operate Seven Of The Most Profitable Businesses At Home. Free Information. WHK, 319 West 6th St., San Pedro, CA 90731.

LEARN Gold, Silver Scrap Recycling Business. Free Information: Recycling, Box 11216PS, Reno, NV 89510.

$1500'S WEEKLY Mailorder Details! Tan, P.O. Box 9338 (PS), Long Beach, CA 90810.

$10,000 MONTHLY Taking Photographs at Home! Call recorded message: (303) 674-8155.

$4,000 WEEKLY. Perfectly legal. First Opportunity, Box 4402176, Miami, FL 33144.

RETIRE! Self Motivated? Seek Challenge? Steady Substantial Income as Distr. w/est'd Consumer Product Comp. Stamped Envelope to: SME Enterprise, Box 187, Blauvelt, NY 10913.

MAKE BIG MONEY AT HOME. Choose your business. Free Information. PAC Distributors, 152 North Cave Spring Street, Cedartown, Georgia 30125.

MAKE PVC PIPE FURNITURE Man proven plans. Profitable home business Free Details J&L Casual Furniture, Bo 208PX Tewksbury, MA 01876.

BE YOUR OWN BOSS

Join #1 multi-level company. **START EARNING MONEY IMMEDIATELY.** Income potential unlimited. Everyone wants products: **NAME BRAND GROCERIES, ELECTRONICS SPORTING GOODS, ETC., UP TO 25% LESS THAN STORES** Work from home by mail. Agent's manual, cassettes complete business plans: $16.95.

FULL MONEY BACK GUARANTEE
SIRIUS PRESS, DEPT. P-1
2325 S.W. 89 Place, Miami, FL 33165

MAILORDER GUIDE - Steps to a profitable business. Plus free booklet of the do and dont's. $5.00 Aqua Enterprises, Dep PS2-9, 826 Ionia Ave Staten Island, N 10309.

INVESTORS need money - here's a opportunity to raise $10,000 - One millio dollars. When banks stop, we start! Ba credit no problem. Send $1.00 for informa tion to: Richard Wilson, 6215 S. Wabash Ste. 304, Chicago, IL 60637.

HOTTEST MULTILEVEL EVER Dynamic new company - started 1/8 gigantic monthly commissions alread paid. Expects national first year sale record! 1-800-624-0894, extension 643. no answer, 1-800-431-1953 or 1-800-34 1950, extension 11.

COMPUTER Owners, Big Bucks! Fre Information: Box 815P, Flushing, N 11362.

MAKE BIG MONEY OPERATING YOU OWN PROFITABLE BUSINESS A HOME. FREE INFORMATION. LAEL' PUBLICATION, 12925 FOXDALE DR SUITE A, MORENO VALLEY, CA 9238

EARN $5,000 Monthly. Sell New Ha Growth Product. Bomart, Box 1417, Suit B41P, Alexandria, VA 22314.

LEARN HOW you can write and mak money from classified ads. They're doing i you can too! rush $10.00: Aqua Ente prises, Dept. PS1-9, 826 Ionia Ave State Island, NY 10309.

SELL HOW-TO BOOKS BY MAI Everything you need. Write: **KIP,** Box 56 Dept. PS10, Lemon Grove, CA 92045.

OUTSTANDING All new money makin home business. Unlimited earning poter tial. Free Information. Hoffman, Bo 61683, Phoenix, AZ 85082.

$40 - $108/hour. Restore Damage Countertops **WITHOUT REPLACEMEN** Millions of apartments, homes pay profi immediately! Free Information. **RENEV** Box 19636-S, Portland, OR 97219.

TRADE $15 FOR $50. Send Sase F Details. R&E Associates, POB 806 Tamuning, Guam 96911.

MAKING EXTRA MONEY MADE EAS FREE Subscription to Opportunity Mag zine offers hundreds of proven ways. Writ Opportunity, Dept I20, 6 N. Michigan, Ch cago, IL 60602.

PART TIME Work - Full Time Pay, Ope ate From Home Selling Business Card Write: Crystal Therm, P.O. Box 2726, Har ford, CT 06146.

MILLIONAIRE IDEA STRATEGY: Sy tax, Box 1294, Walkerton, Ontario, Canac N0G 2V0.

CHRISTIAN Chamber Of Commer Directories needs Assoc. Publishers/Ad Sales Directors Nationwide. 713-256-255 Box 430, Hockley, TX 77447.

YOU too, can make it big in this ne exciting home business. Free details. Loc port Enterprises. 4059-P Lockport, Bridg ton, MO 63044.

SCWL Subliminal Tapes Wholesale: F Free Information Write: Life Enhanc ment, 811 Moulin, Madison Hts. MI 4807

PROFITABLE OCCUPATIONS

HYDRAULIC JACK REPAIR MANU and catalog $5.00. Hydraulic Parts Supp Box 4157, Brownsville, TX 78523-4157.

REPAIR lawnmowers thousands of pa and tools wholesale list 40¢. Ellwange P.S., P.O. Box V, Port Jervis, NY 12771.

FREE. Brochures. Repair air conditio ing. Refrigeration. Tools, supplies, f instructions. Doolco, Inc., 11252 Goo night, Dallas, TX 75229.

GOV'T SURPLUS

MILLIONS OF SURPLUS BARGAINS! Jeeps included! Many 1% original cost. "Nationwide Government Directory"—$2.00 (Guaranteed). Disposal, Box 19107-FJ, Washington, DC 20036.

IS It True You Can Buy Jeeps for $44 through the U.S. government? Get the facts today! Call 1-312-742-1142 Ext. 4606.

GOVERNMENT Money Booklet - Consultation, $24.95. Field. (718) 434-0781. 1116-H, Brooklyn, NY 11230.

LOG CABINS & HOME BUILDING

BUILD your Own Home. Send for 148 Preaddressed Mail Labels for prefab home builders, write and they will send information to you. For labels send $3.50 to: Roy O. Reeves, 4902 Connella Dr, Alexandria, LA 71301.

EDUCATION & INSTRUCTION

FREE Lifetime. Ordination. Become Chaplain, Missionary Evangelist, Bishop. Box 744-PS, McKeesport, PA 15134.

LEARN WHILE ASLEEP! Astonishing New Method! Strange Catalog Free! Auto-suggestion, Box 24-A, Olympia, WA 98507.

UNIVERSITY DEGREES WITHOUT CLASSES. BACHELOR'S, MASTER'S, DOCTORATES. ACCREDITED, INEXPENSIVE, FAST. FREE INFORMATION. DR. JOHN BEAR, P.O. BOX 1447-PSC, MARINA DEL REY, CA 90295.

DEGREE PROGRAMS IN Management, Economics, Philosophy, Business Studies. Credits and Experience accepted. Prospectus (airmailed $2.00) Registrar. Sussex **COLLEGE OF TECHNOLOGY, HIGHFIELD DANEHILL, SUSSEX, ENGLAND** Rh 17 7EX. Founded 1969 students worldwide.

ELECTRONICS B.S. Degree. Correspondence instruction. Accredited, NHSC. Free catalog. Grantham, 10570 Humbolt, Los Alamitos, California 90720.

SUPERLEARNING! Triple learning speed through music! Develop Supermemory; control stress. Free—book excerpt & catalog. Superlearning, 450-PS10 Seventh Avenue, N.Y.C. 10123.

UNIVERSITY Degrees! Economical home study for Bachelor's, Master's, Doctorate. Prestigious faculty counsels for independent study and life experience credits. Free information - Richard Crews, M.D. (Harvard), President, Columbia Pacific University, 1415 Third St., Dept. 2R50, San Rafael, CA 94901: Toll Free: 800/227-0119; California: 800/552-5522; or 415/459-1650.

EARN More in 90 days. Free 1986 catalogue describes 200 success proven correspondence Diploma courses. Granton Institute, 263B Adelaide Street West, Toronto Canada.

HANDLE YOUR OWN LEGAL AFFAIRS. Be a Paralegal. Accredited Attorney Instruction. Home Study. **FREE CATALOG.** Southern Career Institute. Drawer 106PS, 2158, Boca Raton, FL 33427. (305) 368-2522.

UNIVERSITY DEGREES BY MAIL! Bachelors, Masters, PH.D.s...Free revealing details. Counseling, Box 389-SP10, Tustin, CA 92680.

NEED money for college? free scholarship information kit. Educational Services, 231 Central Ave. Fredonia, NY 14063.

WORLD WIDE COLLEGE OF AUCTIONEERING, INC. The original—50 yrs.—World's largest! Term soon. Approved for VA. **FREE** Catalog. 515-423-5242. **COL. GORDON E. TAYLOR,** P.O. Box 949, Dept. 3, Mason City, Iowa 50401.

HIGH SCHOOL Diploma at home. No classes. Low cost. Information **FREE.** Call toll free 1-800-228-5600 or write: American School Dept. 347, 850 E. 58th St., Chicago, IL 60637.

SUPER-INTELLIGENCE! Amazing results guaranteed! Info. EDEPS, Box 1462, Glendora, CA 91740.

UNIVERSITY DEGREES ACCREDITED, by mail. Bachelor, Master's, Ph.D. Details, College Programs, 256 South Robertson, Suite 3024, Beverly Hills, CA 90211. (213-652-6452, Dept. #25)

SCHOLARSHIPS AVAILABLE. 4,000 SOURCES. RESULTS GUARANTEED. CAINCO NATIONAL SCHOLARSHIP SERVICE, BOX 1008-PI, AURORA, CO 80040.

HOME BREWING

BEERMAKERS ONLY! Free Catalog/Newsletter. William's, Box 461-PX, Oakland, CA 94604.

JEWELRY

CLOSEOUT Jewelry. 55¢ dozen (Catalog .25¢). Roussels, 107-1635 Dow, Arlington, MA 02174-7199.

OLD GOLD, JEWELRY WANTED

HIGHEST CASH for Gold, Jewelry, Gold Teeth, Rings, Diamonds, Watches, Silver, Platinum. Mail Articles Today. Free gift with Information. Chicago Gold & Precious Metals, 10 S. Wabash, Dept. 257, Chicago, 60603.

TAKE NO CHANCES. Deal with oldest, most reliable firm in old gold business. Established 1934. We buy Gold, Silver, Platinum, Diamonds. Highest Cash. Free information. Rose Industries, 29-Y East Madison, Chicago 60602.

CARTOONING, SIGN PAINTING

LEARN Sign Painting. Free Catalog. Kaufmann Supply, Centertown, Missouri 65023.

JOKES & NOVELTIES

FREE Catalog! Things you never knew existed! 1600 Novelties, Jokes, Tricks, Science, Hobbies, Sports. Johnson-Smith, F-03, Bradenton, FL 34203-3796.

HOBBIES & COLLECTION

MILITARY Medals Catalogue $1.00. Subscription $6.00. Vernon, Box 1387PS, N. Baldwin, NY 11510.

MAGIC Catalog $1.00. Magic and Fun World, 1717 Wickham Road, Melbourne, FL 32935.

LEATHERCRAFT CATALOG. 100 pages. Largest selection available of genuine leathers, tools, kits, books, supplies. Upholstery, utility leathers, garment leathers, suedes, exotics. Belt, wallet, moccasin kits and more. Send $1.00 pstg/hdlg to: Tandy Leather Company, P.O. Box 2934, Dept PS1086C, Fort Worth, TX 76113.

AIRGUNS

RWS PRECISION AIRGUN PRODUCTS—Air Rifles, Air Pistols for adults, made in Germany with Lifetime Warranty. Meisterkugeln Match, Superpoint, Hollowpoint, Superdome, Hobby, and Standard Pellets. Plus Targets, Traps, Scopes and Accessories. For New 1986 "Precision Products" Catalog send $2.00 for 1st class, $1.00 for 3rd class delivery to: Dynamit Nobel of America, 105 Stonehurst Court, Dept. PS, Northvale, NJ 07647.

PATCHES DECALS & BADGES

GUARANTEED Lowest Emblem Prices! Pins. Decals. Free Catalog/Quotes. Stadri, 61R Jane, NY 10014. (212) 929-2293.

PHOTO FINISHING

KODAK FILM—Only 35¢ A Roll — Details $2.00. Melzl, 29 Whittney, E. Brunswick, NJ 08816.

COMPUTERS

TI-99/4A Software Hardware bargains. Hard to find items. Huge selection. Fast Service. Free Catalog. Enterprises, Box 690, Hicksville, NY 11801.

LEARN about modems. Booklet $5.00 postpaid. Applehaus Ltd., Box 3131, St. Charles, MO 63302.

FLOPPY DISKETTES 5¼" DD DS $1.99ea Famous Brands Computette Computer Services N. 10 Post Spokane, WA 99201.

MAKE MONEY WITH YOUR COMPUTER. FREE Details. Henry Dean, P.O. Box 236, Youngwood, PA 15697.

POWER BROKERS INC

We, A Cybernetic Designing And Consulting Team Can Develop A Personal And Or Business System For You And The Handicap During The Purchase Of Our Catalog Raisonne Which Include A Credit Check Up To $250, So Send A Refundable Check Or Money Order For $11.95 To:

Power Broker Inc., P.O. Box 5411,
Los Angeles, CA 90055.

C64/APPLE programs Cheap! Write: Softwaire Shack, Box 133PS, Fresno, CA 93707-133.

ELECTRONICS, STEREO HI FI

HIGHLY SENSITIVE, ultra - small FM transmitters (bugs). Highest quality, lowest prices. For catalog send $1.00 to: Cony Electronics Distributors, P.O. Box 4172, Springfield, IL 62708.

RADIO/TV

POLICE Scanners, Regency, Bearcat, Fanon. HPR, Box 19224, Denver, CO 80219.

CABLE EQUIPMENT. Guaranteed lowest prices in U.S. Jerrold, Hamlin, Zenith—many others! Lowest dealer prices! Orders shipped within 24 hours! Master-Card—VISA—C.O.D. accepted. Free Catalog—call: (800) 345-8927 only! Pacific Cable Co., Inc., 7325½ Reseda Blvd. #211, Reseda, CA 91335. All other information, call (818) 716-5914.

CABLE TV Equipment. Low prices we ship C.O.D. Send $2.00 for catalog. Cabletronics Unlimited, P.O. Box 266-S, S. Weymouth, MA 02190 (617) 871-6500.

TV Genie VCR in One Room ? Now... You Can, Watch In Any *Room* !

WIRE-LESS TRANSMITTER

TUNES in on UHF Ch 14 ❑ 200 FT RANGE

NEW *AMAZING* PRODUCT FOR ALL, BROADCASTs to All Your TVs

VCR's ❑ Camera's ❑ Satellite Systems ❑ Computers

NO MORE : "MESSY CABLES" OR A-B SWITCHES

CRYSTAL CLEAR PICTURES - EASY "PLUG-IN" SET UP !

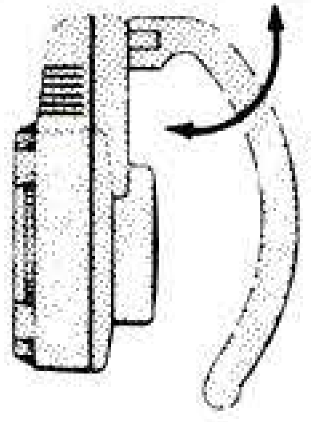
RUSH COD ORDER LINES **800 222-4707** $88

MAIL ORDER's : TV GENIE Co. PO Box 945 GRESHAM OR 97230 DEALERS WANTED

DISCOUNT Catv Converters Equipment And Video Accessories. Free Information. Easy View, P.O. Box 221F, Arlington Heights, IL 60006. (312) 952-8504.

CABLE TV CONVERTERS & EQUIPMENT. Plans and parts. Build or buy. **FREE** information. **C&D ELECTRONICS,** P.O. Box 1402, Dept. PS, Hope, AR 71801.

AMAZING MINI RADIO



BE ALERT!
High-Tech Radio fits over 1 ear. Ideal for Joggers, Hikers, Campers, anyone.

AM $9.95
FM $14.95
(pls $2.50 shp/hdl)

GREAT GIFT!
Special Offer,
Buy 2 or more, save $1 on ea.

30-day money back offer

Send to: PB ENTERPRISES
165-A La Perdiz, San Rafael, CA 94903
(CA res. add 6% sales tax)

WIRELESS INFRARED HEADSET

Enjoy VCR, TV, Stereo, etc. w/o disturbing others and w/o being tied to audio source with a cord. Sound is transmitted silently using infrared light. 50 ft. range. (visible) Only $59.95. Additional receivers $29.95. Optional microphone adapter $19.95. $3.95 shipping. **ART SEA DEVELOPMENT,** 650 S. Spring St. Suite 922, Los Angeles, CA 90014 (213) 627-5553.

BUSINESS SERVICE

MONEY IN YOUR MAILBOX, Selling to our mailorder buyers! Large/small quantities. Introductory offer, 500/$10.00. Free report. Trade Winds-42S, 31 Tracy Rd., New Paltz, NY 12561.

INCORPORATE Without Legal Fees! Free Booklet Tells How. Includes forms. Call now. Harvard Business Services. (800) 345-CORP.

FRESH, HOT, RESPONSIVE "MAILING LISTS." For **FREE** brochure write to: Reymer Associates, Box 412C, New Haven, CT 06513.

RUBBER STAMP

Size: Approx. 5/8"x 2"
A Great Gift!
YOUR NAME & ADDRESS (UP TO 4 LINES) A REAL TIME SAVER!

Order "CUSTOM MADE"
RUBBER STAMPS

UP TO 4 LINES only $2.95 ea.
(Max.30 letters per line)

INK PADS only $1.95 ea.
Specify Color Black, Blue, Red, Green
Add 25¢ per item for postage

SATISFACTION GUARANTEED

FAST SERVICE - Your Order Shipped in 5 days!

QUALITY Stamp Mfg. Box 35514-S, Tulsa, OK 74153

VIDEO

FEELING Scrambled? Here's the answer; **MICROWAVE T.V. RECEIVERS** 20" Dish system (1.9 - 2.7 GHz) lifetime warranty send $89.95 to: **K&S ELECTRONICS,** Box 34522PS, Phoenix, AZ 85067 **$2.00 CREDIT** on phone orders **(602) 230-0640** - Call now for same day shipping! Dealer rates. Brochure, s.a.s.e. Visa/MC/C.O.D.'s/

VIDEO CASSETTE REWINDER! Free Brochure! Midland Mail, 610PV, 103 Godwin, Midland Park, NJ 07432.

VCR's - RADAR DETECTORS WHOLESALE, All brands, (No Escort/Passport). **Free** Delivery, **No tax.** We're Video Specialists, check our prices! 1-800-344-7123.

SATELLITE TV

QUALITY Products Low Prices - Free Brochure and 800 number. SSE, POB 3833, Ocala, FL 32678.

SPECIAL SERVICES

INFORMATION On Anything. Ferguson Research Specialists. 60-15 Woodside Avenue, Woodside, NY 11377.

INFORMATION on any subject. Information Research International, Box 25573, Washington, DC 20007.

PHOTO ID. All Kinds. Free Catalog. Foothills Fastprint, Box PS, Townville, SC 29689.

DOGS

TEACH ANY DOG IN MINUTES

Complete system, book and device. All you need to raise and train puppies, dogs of all ages. Never fails! Uses dog's keenest sense.

EASY TO USE
NOT ELECTRONIC

BEWARE OF IMITATIONS! Our Pat. #3498266 Protects You.

REHABILITATE DOGS: from Electric Shock-Shy , Gun-Shy

CORRECTS ....
- Housesoiling
- Jumping
- Chewing
- Barking
- Biting
- Digging
- Gun Shy
- Breaking Point
- Over Ranging
- Busting Birds

TEACHES ....
- Come-at all times!
- Sit
- Heel
- Stay
- Drop
- Go
- Self Control
- Guard
- Fetch

For: Family Dogs • Hunting Dogs • Stock Dogs • Show Dogs

ON TV with: Barbara Walters, Johnny Carson, Dick Cavett, Art Linkletter, Merv Griffin ARTICLES: SPORTS AFIELD, AMERICAN FIELD, TIME MAGAZINE, TV GUIDE, HUNTING DOG, WALL STREET JOURNAL and others worldwide.

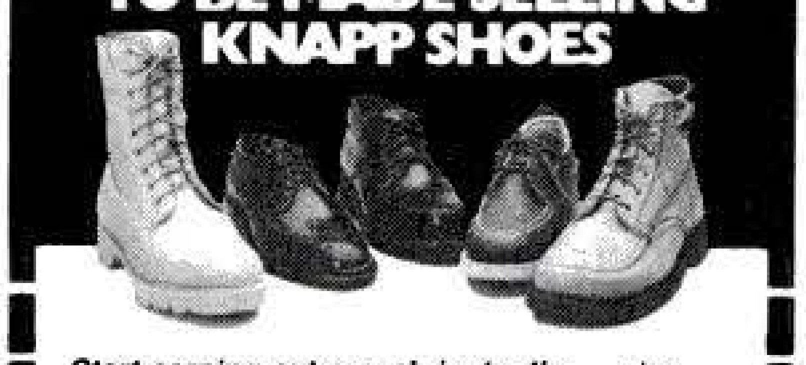
A science engineering breakthrough! A set of unique dog-sound makers that condition dogs incredibly fast. Small. Used from the palm of the hand. Near hypnotic control, even at a distance. No leash needed. Novices become experts. This new discovery is a learning-sound **catalyst** that teaches direct to the dog's mind. Renders bodily paintraining obsolete. Safer. Kind. Yet, more powerful! Dogs simply don't fight it. Tunes dogs in, makes them **want** to please you. Unequaled loyalty-bonding. Same instruments and system (the Dr. Miller patents) dispensed by veterinarians for dog behavior. Now, thousands of satisfied users in U.S. & foreign lands.

From $25 to $175 **FREE catalog**

DOG-MASTER SYSTEMS
4106 Wilshire, Box 250, Agoura Hills, CA 91301
or Call (800) 824-7888 - Ask for operator 656
A Division of Environmental Research Labs. **Copyright © 1986**

SALESPERSON - DISTRIBUTORS WANTED

THERE IS MONEY TO BE MADE SELLING KNAPP SHOES



Start earning extra cash instantly . . . plus receive a 30% discount on a pair of cushion comfort Knapp shoes for yourself from the largest direct selling shoe company in the entire country. Over 20,000 sales people like yourself are making money every day selling from our full color catalog featuring over 250 attractive styles for men and women including dress, casual, work, safety and outdoors. Knapp will send you a complete **FREE SELLING KIT,** including everything you need to get started earning extra money immediately. There is no risk when you sell Knapp shoes. We support our sales people with free training and back our shoes with an unconditional money back guarantee. No cost! No Obligation!

Send coupon today!!

Thomas McCaffrey, KNAPP SHOES, One Knapp Centre
5786 , Brockton, MA 02401

Name ______________________
Address ____________________
City __________ State ____ Zip ______

KNAPP America Works in Knapp Shoes

WANTED TO BUY

AUTOMOBILE LITERATURE WANTED: 1900–1970. I buy automobile sales brochures, manuals. Miller, 6710 Brooklawn, Syracuse, NY 13211.

WINEMAKING

WINEMAKERS—BEERMAKERS Free Catalog. Fast Service. Large Selection. Kraus, Box 7850-N Independence, MO 64053.

WINEMAKERS - Beermakers Free Catalog, Low Prices, Free Recipes. Cellar-S, Box 33525, Seattle, WA 98133.

WINEMAKERS—BEERMAKERS Free Illustrated catalog. Continental, Box 188-PS, Casselberry, FL 32707.

BUY IT WHOLESALE

CLOSEOUTS! Wholesale! Overruns! Freebies! Information (stamp): DDN, Box 20152-G, Ferndale, Michigan 48220.

WHOLESALE PARTS for lawn equipment. Minibikes, Karts, Chainsaws, Small Engines. Quality products. Send $3.00 for full line catalog. GRP Parts, P.O. Box 45245, Dept. S, Somerville, MA 02145.

WORLD Buyer's Guide to Unusual and Innovative products. Information $1.00. Lawler, 76 Wesley Ave., Atlantic Highlands, NJ 07716.

400,000 BARGAINS Below Wholesale! Many Free! Liquidations... Closeouts!... Job Lots... Single Samples. Free details. Worldwide Bargainhunters. Box 730-B, Holland, MI 49424.

RADAR DETECTORS, CB's, Scanners, Cordless Phones, Answering Machines, Commodore Computers, Video Tape. **SAVE UP TO 50%** on Cobra, Phonemate Bel, Panasonic, Uniden, Spectrum, TDK, K40, More! **FREE PRICE LIST.** Computronix, 615 Milwaukee #3PS, Glenview, IL 60025, **1-800-237-BUYS,** 1-312-729-BUYS. VISA, COD.

FLEA MARKET SUPPLY DIRECTORY. Below wholesale sources. $2.00. Clifford-S, Box 128, Olyphant, PA 18447.

ENGINEERING & PROFESSIONAL SVC.

INVENTREPRENEUR

QUARTERLY PUBLICATION FOR PROBLEM SOLVERS AND PROBLEM POSERS. INVENTREPRENEUR PROVIDES A MEETING PLACE FOR INVENTORS AND ENTREPRENEURS. INVENTREPRENUER FEATURES:

- PROBLEMS POSED BY COMPANIES, CLUBS, INDIVIDUALS
- INVENTREPRENEURS' SOLUTIONS TO PROBLEMS
- ENGINEERING & BUSINESS TOPICS (NEXT ISSUE, "THE HYDROGEN ECONOMY")

BECOME AN INVENTREPRENEUR TODAY!! $12 ONE YEAR
EASON CONCEPTS
1284 WEST CRESCENT, REDLANDS, CA 92373

PLASTICS

CASTOLITE Liquid Plastics. Crystal clear, colors. For casting, embedding, coating, fiberglassing; in industry, laboratories, craft work. Reproduce your designs with our mold materials. Catalog $2.00. Castolite, Dept. 86N/PS, Box 391, Woodstock, IL 60098.

HYPNOTISM

FREE Hypnotism. Sleep Learning Publication DLP, Box 487, Anaheim. CA 92705.

FREE Hypnotism, Self-Hypnosis, Sleep Learning Catalog! Drawer PS400, Ruidoso, NM 88345.

PERSONAL

FREE information, how to become a minister and establish a church. WCL, Box 26, Joelton, TN 37080.

BORROW 5,000.00. No credit or employment needed. 24 hrs. call (702) 788-9299.

HERBS - Yohimbine, Pau D' Arco, FeverFew, Catalog $1.00 (refundable) Jude Herbs, Box 563PS, Huntington Station, NY 11746.

MONEYMAKING OPPORTUNITIES

BORROW $300-$30,000 Worry Free! Keep Indefinitely! Free Details! Write: American, 1601 Main, Plainfield, IN 46168.

GOLD Stamping Machines. Inexpensive. Quality. Large imprint Area. Free details. Magic Systems, POB 24986 (LLD), Tampa, FL 33623.

$100's WEEKLY Clipping newspaper articles. Free information. MCPI-NC, 231-32 Merrick Blvd., Laurelton, NY 11413.

$1,000 WEEKLY Home Business Directory. Details. Box 2019-PS, New York, NY 10163.

GET RICH!! Secret law smashes debts—brings cash credit! **FREE** report!! Wealth-Kit-S, Box 4036, Pompano, FL 33063.

"$1,000's WEEKLY"!** Mailing Letter$! **FANTASTIC OPPORTUNITY! $tart Immediately! **EXCITING FREE DETAILS!** Write: **$UCCESS,** #605-PS, Dresher, PA 19025.

BORROW $500–$40,000! "Overnight" On Signature. Keep indefinitely! Write: Action PM-10, 3660 Wilshire, Los Angeles, CA 90010.

WANT MORE MONEY? WE CAN HELP YOU GET IT. FREE INFO. Crestwood, Box 1280, Shingle Spgs. CA 95682.

BUMPER Sticker Printer. Cheap, Simple, Portable, Free details Bumper, POB 22791 (LLD), Tampa, FL 33622.

HIGH Profits T-Shirts and Caps. Inexpensive, professional transfer machines, supplies. Press Magic, P.O. Box 22809-LLD, Tampa, FL 33623.

HOW would you like to receive 100 letters daily, each containing $2.00? Copy of plan and formulas only $2.00. Rush $2.00 to: Gray Enterprises, Box 5242, Lake Charles, LA 70606.

SEVEN most profitable home based businesses. Exciting opportunity requiring little capital. Outlay for complete details write to: Danooggie Enterprises, P.O. Box 250, Hinsdale, NY 14743.

WANT To Win Money In Lotteries $1.00. To: RCD, 314 16th, Hereford, TX 79045.

THE SECRETS to starting a **LUCRATIVE** business at home. **FREE** details. T.M. Company, 1807 Young, Cincinnati, OH 45210.

EARN $5,000 ANY WEEKEND! Amazing new system makes it easy. No money needed. Skeptical? **FREE PROOF.** Write: Crossroads, Box 5097-K1 Babylon, NY 11707.

SAVE MONEY, SOLVE PROBLEMS, simplify budgeting, no work, proven 10 + Years. Send $3.00. Behr Enterprises, Box 41766 (PS10), Phoenix, AZ 85080.

MONEY - to start a business or pay your bills. How to kit $19.95. Free info: send sase to: Information Service, PO Box 219, Herndon, VA 22070.

ONCE IN A LIFETIME! Unique Money Making Opportunity! Free Details! R.M., P.O. Box 700086-B, San Jose, CA 95170-0086.

NEW! "Secrets Of Success In Selling." Amazing "How To" book multiplies your $ Earnings **QUICKLY. FREE DETAILS.** Whiteside Publishers, 5157C Sandy Shore, Sarasota, FL 34242, (813) 349-8991.

LOANS BY MAIL

IMMEDIATE Loans to deserving individuals refused elsewhere. Many plans included. Try us! Associates, Box 98-P3, Brooklyn, NY 11235.

BORROW $300–$30,000 Worry Free! Keep Indefinitely! Free Details! Write: American, 1601 Main, Plainfield, IN 46168.

BORROW $35,000 "overnight." Any purpose! Free Report. Success Research, Box 19739-FX, Indianapolis, IN 46219.

BORROW $100—$100,000! Instant Reply! Rush stamped envelope! Marigold, Box 2030, (PS), Richardson, TX 75080.

BORROW $500-40,000! "Overnight" On Signature. Keep indefinitely! Write: Action PL-10, 3660 Wilshire, Los Angeles, CA 90010.

GET VISA and **MASTERCARD** proven system, positive results **GUARANTEED!** Free Detail, Financial, 535-52, Bellwood, IL 60104.

NEED MONEY? Cash, Loans, Government Grants. 99% eligible-no investigation. KPA, Box 373-FNM, Woodmere, New York 11598.

MIDEAST BUSINESSMEN Have Money to Buy & Invest. Top Finders Fees Paid. IMEA, 1086PS1, Box 3574, Newport Beach, CA 92663.

FREE MONEY! $300,000,000 Giveaway. Grants. Never repay. Details $1.00. Jakla, Box 3066-PS10, Seminole, FL 33542.

LOANS. Venture capital for business expansion/inventions/other purposes. **FINANCE,** Box 1015, Carlisle, PA 17013-6015.

100's Of Visa & Mastercards available. Guaranteed!! Send $10.95 to: Credit Security Inc., 1055 N. LaJolla #7, Los Angeles, CA 90046.

REMAILING SERVICES

FREE Information! Postal Shoppe, 369 East 900 South, Salt Lake City, UT 84111.

CONFIDENTIAL Mail Receiving Forwarding. Mail Drop. Box 18039PS, Orlando, FL 32860.

PRIVACY MAILDROP!...Miniature Transmitters, **ELECTRONIC DEVICES** $1.00. Protector, P.O. Box 520294, Salt Lake City, UT 84152.

EMPLOYMENT INFORMATION

OVERSEAS... $25,000-$65,000 +. Free Report! Employment, Box 19760-FX, Indianapolis, IN 46219.

JOBS, Cruiseships, Tugs, Ships, Riverboats, Oilrigs: Women-Men. Work month-Home month. USA + Overseas. Information $3.00 Marine Employment, Box 223, Central, IN 47110.

POLICE, Security and related careers are open now...nationwide. Detailed listings. Stamped envelope brings information: PSIC, POB 1562, Decatur, IL 62525.

MAILING LISTS

FREE Mailing List Consultation. Details. GOC-31U, Box 1107, Stuart, FL 33494. (305) 334-5205. 1-800-554-5478.

EXCLUSIVE Mailing List of Opportunity Seekers. **SASE** to: **AVERY,** Box 398, Hicksville, NY 11802.

EARN bigger profits! Professional top of the line computerized full feature mailing lists $3/100, $20/1000 names. Lone Star Products, 1612 N.W. 21st, Fort Worth, TX 76106-7832.

SUCCESSFUL MAIL LISTS
Fresh, computerized Buyers. For all details: Iowa Sales Co., 1200 S. Grandview, Suite 1, Dubuque, IA 52001.

MAKE MONEY SELLING to **COMPUTERIZED MAILORDER BUYERS!! FREE VALUABLE REPORTS!!! ESAN,** Box 541-SA, Brooklyn, NY 11226.

FRESH Opportunity Seekers. **OVERNIGHT SHIPMENT!** Adhesive Labels. 500/$25; 1000/$40; 5000/$175. Others. **ADVON,** Drawer B6, Shelley, ID 83274. Visa/MasterCard, AmEx 1-800-992-3866.

BEST MOST PRODUCTIVE mailing lists available. For information write: SMJ Associates, 325 Second Avenue, Lock Haven, PA 17745.

FRESH, HOT, RESPONSIVE NAME LISTS Of Mailorder **BUYERS.** Most Categories. Computerized In **ZIP CODE ORDER.** Peel and Stick Labels. **GUARANTEED DELIVERABLE!!** For Brochure **RUSH SASE** To: **THE MAIL LISTS FACTORY,** Dept. PS, 320 N. Plymouth Blvd., Los Angeles, CA 90004

FOREIGN NEWSPAPERS

NEW! WORLDWIDE ENGLISH MAGAZINES. Sampler: $2.49. **FREE BROCHURE.** Multinewspapers, Box DE-30, Dana Point, CA 92629.

FOR INVENTORS

PATENT IT ECONOMICALLY! Free details. Licensed since 1958. Rainer Associates, 2008 Fondulac, Richmond, VA 23229.

NONPROFIT foundation helping inventors over 11 years. Free recording forms. Free evaluation. Affiliated Inventors Foundation, 501-A Iowa, Colorado Springs, CO 80909 or Call 1-800-525-5885.

HAVE YOUR INVENTION MADE OVERSEAS. World Trade Associates, Box 789, Adelphia, MD 20783.

BEFORE you waste thousands, get The **"SUCCESSFUL INVENTOR'S HAND GUIDE"** Book. Step by Step instructions Send Check or M.O. for $8.95 to: D&E ENTERPRISES, P.O. Box 1121, Longmont CO 80501.

REGISTERED PATENT ATTORNEY wil evaluate invention, prepare and prosecute patent application. Reasonable rates Edwin Schindler, 1523 East 4 Street Brooklyn, New York 11230.

INVENTORS! Can you patent and profit from your idea? Call or write for your free information package. Over a decade o service. **AMERICAN INVENTORS CORPORATION,** 82 Broad Street, Dept. PS Westfield, Massachusetts, 01086. 1-800-338-5656. In Massachusetts or Canada call (413) 568-3753.

LEARN how to offer your invention fo sale or license. Free Booklet. Outlines procedures, royalty rates, requirements. Kessler Sales Corporation, C-7-FI, Fremont OH 43420.

INVENTIONS WANTED

INVENTIONS Developed Marketed Free Invention Certificates. **MANUFACTURERS REPRESENTATIVE,** Suite 3615-PS, Woolworth Building, New York, NY 10007.

INVENTORS! Confused? Need help Call AIM for free information kit. Toll free 1-800-225-5800.

IDEAS, INVENTIONS, NEW PRODUCTS WANTED FOR
Presentation to industry and exhibition at national innovation exposition. Call free 1-800-528-6050. Canada, 1-800-528-6060 X831. Or write:
INVENTION SUBMISSION CORP-PS
903 Liberty Avenue
Pittsburgh, PA 15222

NEW IDEA? American Patent in Washington, D.C. will assist you through **RESEARCH** and **DEVELOPMENT!** Free Kit—1-800-257-7880.

HONGKONG factory needs several new products for their overseas buyers. Sen product ideas for royalty evaluation. Ca produce exclusively Hongkong Plasti Metal Products Company, Box 69627 Kwuntong, Hongkong.

INVENTORS: If you have an inventio for sale or licenses, write for free bookle explaining how we can help you. Kessle Sales Corp. C-7-IW, Freemont, OH 43420

NATIONAL Manufacturing/Marketin Company seeks new products, ideas Industrial, automotive equipment. 1-800 232-5847.

SCIENCE & CHEMISTRY

225 PAGES! 1984 Glassware—Chemical — Lab. Equipment — Experiments Most comprehensive catalog offered b anyone in this column. Established 1970 $3.00 **REFUNDABLE.** Aldrich Scientifi P.O. Box 675-PS70, Helotes, TX 78023.

"EXPERIMENTERS" LABORATOR CHEMICALS—GLASSWARE. Catalogu $1.00. **HAGENOW LABORATORIES,** 130 Washington. **MANITOWOC, WI** 54220.

CHEMICALS/LAB EQUIPMENT
LOW Prices glassware, mantles scales microscopes, Catalogs. Chemical $3.00 Equipment $4.00 both $5.00. **CHEM-LAB** 13814 Inglewood, Hawthorne, CA 90250.

FREE SCIENTIFIC CATALOG R.J.M Laboratories, Inc. presents its latest cata log containing scientific laboratory equip ment and supplies, including a complet line of specialty laboratory glasswar Write today for your **FREE** catalog: R.J.M Laboratories, (I) P.O. Box 899, Santee, C 92071.

ANATOMICAL CHARTS, MODELS SKELETONS, $1.00 Catalog. **CHARTS** 7124 North Clark, Chicago, IL 60626.

1987 CATALOG, 200 pages. Chemistr Biology, Physical & Earth Science, Natur Dinosaurs and much more. Beginner t professional. $2.00. Merrell Scientifi 1665 Buffalo Rd., Rochester, NY 14624.

HUMANS can detect magnetic fiel Instructions $5.00. Research and Develop ment, P.O. Box 465, Parkersburg, WV 26102.

BODY BUILDING

FITNESS CHARTS, Free Catalo **CHARTS,** 7124 North Clark, Chicago, I 60626.

DETECTIVES

PRIVATE INVESTIGATOR Home-study raining Program. Free Information. lobal, Box 191PS, Hanover, MA 02339.

DETECTIVE SPECIAL. HI-TECH LECTRONICS, BOOKS, WEAPONS, ND MUCH MORE. WORLD'S BEST ELECTION. GIANT CATALOG ONLY $2. OUBLE MONEY BACK GUARANTEE. IUNTER, BOX 12922, WINSTON-ALEM, NC 27117.

MUSICAL INSTRUMENTS

INTERNATIONAL VIOLIN COMPANY, atalog for instrument makers, repairers. mported tonewood, tools, varnishes, parts, ccessories, strings, cases. European nstruments. Bows. Assemble yourself vioin and guitar kits. Catalog $1.00 includes 0% discount certificate. Dept. LJ, 4026 W. elvedere Ave., Baltimore, MD 21215.

FREE music catalog - exciting teach ourself courses! Davidsons, 6727PS Metalf, Shawnee Mission, KS 66204.

SONGWRITERS

POEMS–SONGS WANTED. Free Pubishing/Promotions. Broadway Music, Box 438-PS, Sarasota, FL 33578.

BOOKS & MAGAZINES

FAMILY Bibles - Beautiful Bible Stories, aped Bible Cassettes. Details $2.00. Brides, Box 5460, Hollywood, FL 33083.

INDEXES to **POPULAR SCIENCE** vailable; full set of 13 for $13, postage aid. For 1984 only, send $1.75 to: **POPUAR SCIENCE INDEXES,** Box 2017, atham, NY 12111.

READY REFERENCE. Preserve your opies of Popular Science for future refernce with handsome library cases. Each turdy, durable case holds a year's issues. overed in bright red simulated leather ith the logo embossed in gold. $7.95 each, for $21.95 or 6 for $39.95. Add $1 per unit ostage & handling, USA only. PA resients add 6% sales tax. Send check or oney order to Jesse Jones Box Corp., ept. PS, 499 East Erie Ave., Philadelphia, A 19134.

PUBLISH Your Book! Join our successl authors. All subjects invited. Publicity, dvertising, beautiful books. Send for factlled booklet and free manuscript report. arlton Press, Dept. PS, 11 West 32 Street, ew York 10001.

TELECOMMUTING: Relief for congeson in Centralized Areas $3.50. TeleCot, ox 51381, San Jose, CA 95151-5381.

STAMP COLLECTING

FREE: Discount Stamp Catalogue, Shelon, Box 547B, North Miami, FL 33161.

FREE Surprise collection with approvls. Jay, Box 2130, Petaluma, CA 94953.

PENNY Stamp Approvals. Regardless atalog. C. Kloster, 4164 52nd St, San iego, CA 92105.

SPECTACULAR! 300 Breathtaking tamps from 35 Countries. Only $1.00 with test bargains and sensational approvals. tamps +, Dept. SJ6, Box 982F, Toronto, anada M4Y 2N9.

FREE, U.S. Mint Set. Approvals. Hilderand, Box 4867, Santa Clara, CA 95054.

FREE US MINT CATALOGING $1.00. ith Approvals. Carlson, Rt. 2, Box 112P, nnandale, MN 55302.

COINS & CURRENCY

DOUBLOONS! Five Mardi Gras douoons $2.00. Free Pricelist. Worthy Coin, ox 53, Granby, MA 01033.

OF INTEREST TO ALL

MESSIAH PROMISED LIFE TO THE VERCOMER. Send for your free copy "The Psychology of Purity & Chasty" to: Schizophrenics International, O. Box 50456, Ft. Worth, TX 76105.

WITCHCRAFT — HARNESS THE ORCE. Understand the Old Religion and e consensus reality. Gavin and Yvonne, ox 1502PS, New Bern, NC 28560.

GIFTS FOR EVERY BUDGET - Handmade wood and country crafts. Catalog $2.00. J.W. Crafts, Dept. PS2, Box 153, Wellsville, NY 14895.

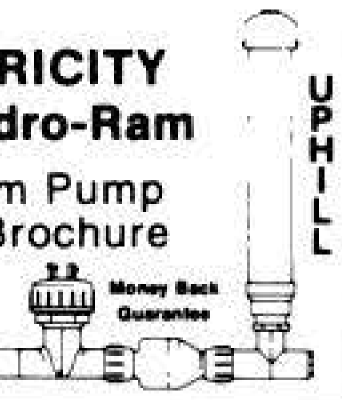
REWARD your dog. Home Bake California's preferred, all natural pet treat recipe. Dog's love 'em. Order now and receive free cookie cutter. Rush $6.50 + $1.50 for s/h to: Sunibelle, P.O. Box 30483, Walnut Creek, CA 94598.

Tipping Guide

Never Be Embarrassed Or Wonder About Tipping Again! Complete Guide Including Tipping History Which Dates Back To The Eighteenth And Nineteenth Centuries. Send $1.25 Along With Self Addressed Stamped Envelope To: The Tipping Card Co., P.O. Box 3095, St. Charles, MO 63302

Money Back Guaranteed

PUMP WATER
NO GAS/ELECTRICITY
with Fleming Hydro-Ram
Send $94.75 for Ram Pump
$3.00 for Detailed Brochure



RAM CO. Box 698S
Amherst, VA 24521
(804) 277-8511

10c For Kodak color print film when processing with color pro. Information send sase. Nova Enterprise, P.O. Box 351441PS, Los Angeles, CA 90035.

FORMULAS, PLANS

MONEYMAKING CHEMICAL FORMULAS—THOUSANDS! CATALOG $5.00 (REFUNDABLE!): GWA6, Box 193, Brookfield, WI 53008-0193.

HENLEY'S
20th Century Book of
10,000 Recipes, Formulas & Processes
(Latest Edition)

Here is a wealth of practical, accurate and clear information and instruction that can save you thousands, or make you a fortune! Housewives, manufacturers, farmers, handymen, home experimenters, electricians, chemists, people in every walk of life, refer to Henley's daily. In this gold-mine of a book, you too will find formulas and recipes for almost everything used in the home, farm, workshop or industry. Discover the trade secrets of thousands of commercial products—learn new money-savings and exciting way of doing things. As indispensable as a dictionary. Satisfaction guaranteed. 900 pages hard cover-cloth binding. Only $16.95 plus $1.95* postage & handling.
Dealer's Inquiries Invited

EMBASSY SALES Dept. PS 78
Box 67, East Elmhurst, N.Y. 11369

WATER PURIFICATION

DRINK PUREST WATER! Home Distillers. Discount Prices! 800-874-9028. **WATERWISE,** Box 45981, Center Hill, FL 34254-0459.

HEARING AIDS

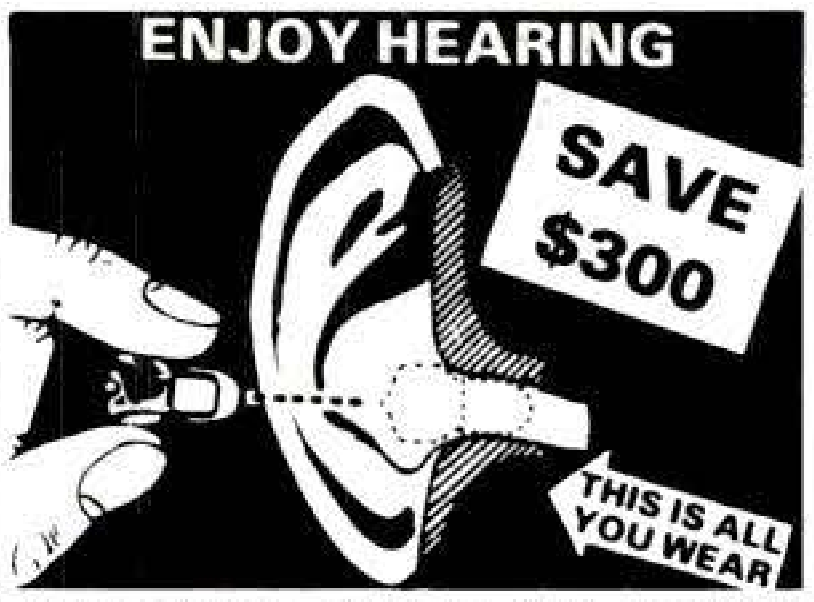
HUGE SAVINGS. Eliminate dealer markup. Free Trial. Batteries wholesale. Terms Arranged. Lloyds-PSC, Rockford, IL 61104. Call 1 800 323-1212 Toll Free.

GIANT SAVINGS Custom In-The-Ear Specialists. 30 Day Trial Terms. Riteway, Box 59451S, Chicago, IL 60659.

HEARING AIDS
½ PRICE CATALOG FREE!

SUPER $AVINGS! Newest. Finest. All types. Buy DIRECT & save up to HALF! No salesmen. Sold by AIR MAIL on HOME TRIAL. FREE Catalog. Write:

MONEY$AVERS,
Dept. PS10D 9530 Langdon Ave.,
Sepulveda, Cal. 91343



All-in-the-ear Hearing Aid! Nothing over, under or behind the ear . . no cords, tubes or wires. Simple slip-in fit. Full range volume control. 45 day trial. *NO* salesman will call. Order your free catalog! Write Better Hearing today!

or call 24 hrs./day
1-800-824-7888
ask for **Operator No. 372**

BETTER HEARING
Box 569-69R Brookport, IL 62910

HEARING AIDS REPAIRS. All makes and models. Huge savings Eliminate dealer markup. Fast Service All repairs $29.50 ppd. Horizon, Box 1422, Gracie Station, New York, NY 10028.

WEARING APPAREL

WATERPROOF your Boots! Send $5.00 for **ROSCOE'S LEATHER DRESSING.** To: P.O. Box 981, Goshen, IN 46526.

TREASURE FINDERS/ METAL DETECTORS

FIND old coins, jewelry, gold nuggets. New patented revolutionary device. Free catalog. Gardiner, 4729L N. 7th Ave., Phoenix, AZ 85013.

Pay For Your Hobby!
With White's NEW Professional Series Metal Detectors

Call Toll Free:
1-800-547-6911

WHITE'S ELECTRONICS
Dept. PB-6 Sweet Home, OR 97386

BURIED TREASURE

Locate from a LONG DISTANCE
with Ultra-Sensitive *DIRECTIONAL* Locator
SEND FOR
FREE INFORMATIVE BROCHURE
RESEARCH PRODUCTS
BOX 270270-H TAMPA, FLORIDA 33688

FIND GOLD COINS, VALUED up to $10,000 each, How and where, $3, Wilson, 4415 Brookton, South Bend, IN 46614.

MODELS, SHIP, CARS, PLANES

WORKING STEAM MODELS

KITS or ASSEMBLED.
Tractors, Locomotives, Limousine, Roadster, Truck, Engines. Two Steam Books total 59 Color pages $4.95 (Refundable). Colored Circular $1.00 Summer discounts 20%.

DIAMOND ENTERPRISES
Dept PSM, Box 537, Alexandria Bay, NY 13607
Phone: (613)-475-1771

MISCELLANEOUS

COAT OF ARMS Free colour brochure, Liberty Sales, Box 172, Rockwood, Ont., Can. N0B 2K0.

SUPER - SHEARS cuts through Steel wire, Sheet metal, Hardboard, Strapping, Plastic, Leather. $12.95 plus $1.00 p&h. Dickman Enterprises, 197 New Liberty, P.O. Box 95, Jacksonville, AL 36265.

GOOD EATING

NoMMEHFF VEGETARIAN COOKBOOK. No **MEAT MILK EGGS HONEY FISH** or **FOWL.** Over 100 recipes, reasons, exercises, rubdown instructions, hydrotherapy. $15 to: Humane Engineering, P.O. Box 593314, Orlando, FL 32859.

GREAT GRANDMA'S mouth-watering chicken pot pie. Guarded recipe $3.00, Helen Albertson, Bx 535 Rt. 706, Sicklerville, NJ 08081.

BETTER HEALTH

FINGERNAIL FUNGUS? Inexpensive natural cure. Guaranteed. $10.00. HMC, Box 150-P, Milltown, NJ 08850.

Lila™ TONGUE CLEANER
THE PREVENTIVE DENTISTRY TOOL

- **Prevents dental plaque. Cuts dentist's bills.**
- **Freshens breath natural way.**
- **Time proven tool. Used 2000 years**
- **Lifetime stainless steel.**
- **Year-round gift item.**

THE REAL TRUTH ABOUT BAD BREATH AND CAVITIES: Your tongue traps food particles. They decompose to cause bad breath. They combine with saliva and bacteria to form plaque—a major cause of cavities. The LILA Tongue Cleaner is a simple age-old device that takes plaque off your tongue, so it stays off your teeth and does it safely, quickly and with remarkable ease. Even occasional use will gratify you. Used in ancient Rome and now very common in the Orient where doctors and dentists prefer a tongue cleaner to tongue brushing and America is just catching up.

Money-back guarantee.

LILA NEVREKAR, M.D.
805 East Midland, Suite 130
Shawnee, Oklahoma 74801

☐ 1 for $6.95
☐ 2 for $9.95
(includes $1 s&h)

I BEAT HEART-ATTACK

I CONQUERED HEART ATTACK. Get Powerful information. PROOF of healing of Blocked Arteries . . . Chest & Arm Pain . . . Weak Heart . . . Poor Circulation . . . Rapid Aging, and other symptoms. Painless relief plan. Helping others. SEND NO MONEY—only name & address to: Survival-46, Box 3256, Austin, Texas 78764.

SPORTING GOODS

NEW 6 FT. "4 IN 1" TAKE-DOWN BLOWGUN
New 1987 Survival-Hunting "Commando"™ Models
Actual Photos
2/3 OFF
Now get 4 blowguns in 1
Aluminum collars. All guns fully assembled—No Kits!
135 FREE DARTS Camouflaged. Free quiver holds 12 darts
Combined get 2 ft. gun+3½ ft. gun+4½ ft.=6 ft. gun
REG. $29.95
FROM 8.95 +POST.
Use 30-Days No Risk!
USA Made
35-lbs. Anteater killed without poison.
Millions sold! Beware of copies! World's finest, fastest, since 1968

For Camouflage or Black models add $3.00 each gun.

Regular Models	Range in Feet	1- or 2-piece "take-downs"
2 ft. INDOOR	20'	$8.95
3½ ft.	110'	9.95
4½ ft.	220'	10.95
5½ ft.	300'	11.95
6 ft.	350'	12.95
3-piece "4-in-1" Guns		
6 ft.	350'	$17.95
8 ft.	450'	22.95
9 ft.	550'	24.95

Add $1.95 postage EACH paid gun.

DEALERS—1 OR 2 PC. GUNS

12-2 ft.	$72.00	12-5½ ft.	$96.00
12-3½ ft.	79.00	12-6 ft.	102.00
12-4½ ft.	89.00	12-6 ft. 3-pc.	120.00

SILENT, POWERFUL, ACCURA bullet impact! Kills game, blasts varmints, pests! Target, plinking, thrilling sport! Astound friends! Compressed breath gives rifle power! Pierces ½" wood! NOT A TOY! Rugged aluminum. Ideal gift! 135 steel darts, instruc. **Extra darts** 100/$3.50, 200/$5.95, 500/$14.00, K/$25.00. **Cone darts** 100/$8.88, 200/$16.88, 500/$39.88. **Broadhead tips** 112/$5.90, 224/$10.95, 560/$24.90. **Bonus: Buy 2 guns get 600 darts!** quivers! targets! poison info! carry case! **Buy 3** same+ 900 darts! **Buy 4** same+ 1100 darts+ free 2' gun! **Buy 5,** same+ 1300, + free 7th gun! **Buy 6,** same+ 1600+ free 8th gun! 30-day money back guar. Lifetime breakage guar. 1-Day service, cash, check, M.O.

VISA, M.C., AM.X. (C.O.D. $3.50 C.O.D. FEE $20 MINIMUM) 24-HRS. FREE 1-800-222-3119 8-4 M-F
or 1-800-824-7888 OP.636 No C.O.D.'s to this number **Blowgun World, Inc.** Box 25183-P Salt Lake City, UT 84125

Product Information

Booklets, catalogs, and folders listed below provide reliable information, illustrations, and specifications to help you in planning the purchase of a variety of products or services offered by these dependable companies. The convenient order form will save you time and postage. **Orders will not be processed unless accompanied by the $1 handling fee. For your safety, please do not send cash.**

1001 Boating Bayliner Marine Corp.'s new catalog displays the firm's complete line for 1986. Sporty runabout packages to world-class luxury motor yachts are featured, all with the high quality, standard equipment, and value that Bayliner provides. Free

1002 Hunting Equipment A new full-color catalog from Browning lists the company's complete line of sporting arms, gun accessories, gun safes, archery equipment, gun cases, clothing, boots, and knives. Free

1003 Graphics Calculator Casio's new catalog introduces its FX-7000G, the world's first business and scientific calculator with a graphics display. The unit instantly draws graphs that represent formulas or data. It also has 192 functions, a 422-step memory, and mathematics capabilities. Free

1004 Optics A pictorial catalog from Celestron International lists the firm's complete line of telescopes, spotting scopes, binoculars, and accessories. It also contains purchasing and user tips. $3

1005 Insulated Glass Color literature from Crestline shows the company's full line of wood windows and patio doors made with iPLUS4 high-performance insulated glass. The insulation reduces energy cost, minimizes condensation damage, improves comfort level, and resists fading. Free

1006 Speed Boats A full-color 32-page 1986 catalog from Donzi Marine lists its internationally known line of high-performance 18- to 33-foot fiberglass speed boats. $5

1007 Hard-to-Find Products Edmund Scientific's new 60-page catalog contains more than 1,200 hard-to-find products such as magnifiers, optics, telescopes, microscopes, motors, health and fitness items, and more. Free

1008 Picture Accessories This full-color catalog from Exposures is designed to get your favorite photos out of drawers and shoe boxes. The literature lists a selection of antique frames, unique photo albums, designer picture organizers, slide-viewing equipment, and more. $1

1009 Solar Heating A solar planning kit from Hanson Energy describes how its TA-3 space-heating system brings you the free warmth of the sun, saving you money on your heating bills. $1

1010 Oil Coolers This brochure from Hayden is entitled "Oil Cooling: Who Needs It?" It tells how increased oil temperature affects the life of your car's transmission and engine, and how Hayden oil coolers can increase their life expectancy. Free

1011 Timepieces The full-color 1986 catalog from Innovative Time includes a special fall supplement and features a wide range of fashion and sport timepieces, including temperature watches, world-time calculators, calorie-counting pedometer stopwatches, and custom-designed and inscribed watches tailored for you or your company. Free

1012 Home Heating A four-color 10-page brochure from Kent Heating describes its full line of award-winning wood stoves and fireplace inserts. The literature includes complete specifications, installation clearance requirements, operating tips, technical data, and general information on heating your home with wood. Free

1013 Residential Locksets This full-color brochure from Kwikset, America's largest-selling residential lockset maker, describes the company's unique designs and architectural lockset styles for the home. Doorknobs, levers, entrance handle sets, and deadlocks are shown. 35¢

1014 Overload Control A color brochure from Load Toter Mfg. Co. explains its patented pickup-truck overload control. The company says the system increases payload capacity 100 percent and acts as an anti-sway and stabilizer bar, eliminating fishtailing and bottoming out. The controller comes into play only when the truck is loaded; it installs in 30 minutes and is guaranteed for life. 25¢

1015 Guide to Boat Buying This booklet of boat-buying tips for beginners includes information on the types of boats available, how to shop for the right boat, and how to finance a purchase. Free

1016 Leisure Boats Godfrey Marine's two color catalogs feature its line of cruising, fishing, and water-skiing boats, including 19 low-cost inboard and outboard designs. Free

1017 Outdoor Power Equipment Shindaiwa's illustrated catalog describes the Japanese manufacturer's full line of professional-quality chain saws, grass trimmers, brush cutters, blowers, hedge trimmers, water pumps, cutoff saws, and generators. Free

1018 Outboards Suzuki Outboards' two full-color catalogs describe its 1987 outboards, from the 2-hp model to the 200-hp V6, with True Oil Injection and Power Trim standard on many models. The Suzuki 150 Super Six is the only V6 with production dual plug heads. Free

1019 Quality Cigars Get better cigars at better prices. Literature from Thompson Cigar Co. lists more than 100 different custom-made, factory-fresh cigars, which come directly from Tampa, Fla., the nation's fine-cigar capital. Free

1020 Electronic Keyboards A three-page brochure from Yamaha lists 10 portable electronic keyboards, with a description and picture of each. Free

FILL IN COUPON AND MAIL TODAY

POPULAR SCIENCE P.O. Box 322, Dalton, Mass. 01226

Note: Popular Science Massachusetts address is for Product Information only.

THIS COUPON EXPIRES DECEMBER 31, 1986

Please send the items checked below. I am enclosing $1 handling charge (any number of items **per coupon**) plus amount required for priced items. **Orders will not be processed unless accompanied by the $1 handling fee. Do not send cash.**

☐ 1001
☐ 1002
☐ 1003
☐ 1004 $3
☐ 1005
☐ 1006 $5
☐ 1007
☐ 1008 $1
☐ 1009 $1
☐ 1010
☐ 1011
☐ 1012
☐ 1013 35¢
☐ 1014 25¢
☐ 1015
☐ 1016
☐ 1017
☐ 1018
☐ 1019
☐ 1020

I AM ENCLOSING

$__________ **for priced items**
$ 1.00 **for handling**
$__________ **TOTAL REMITTANCE**

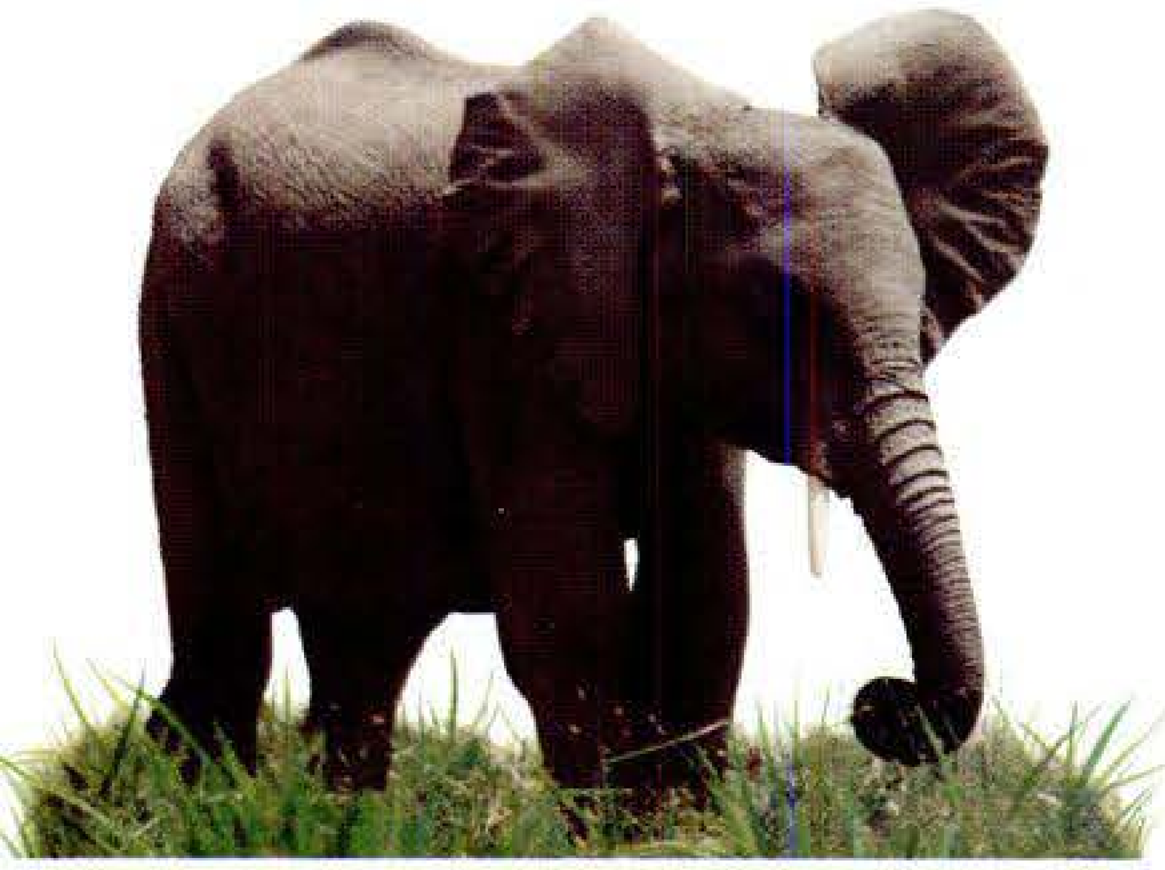
Name (please print) ____________________

Address ____________ **City & State** ____________ **Zip** ________

Please send check or money order made out to Popular Science.
No stamps or foreign currency. Allow approximately six weeks' delivery.

POPULAR SCIENCE OCTOBER 1986

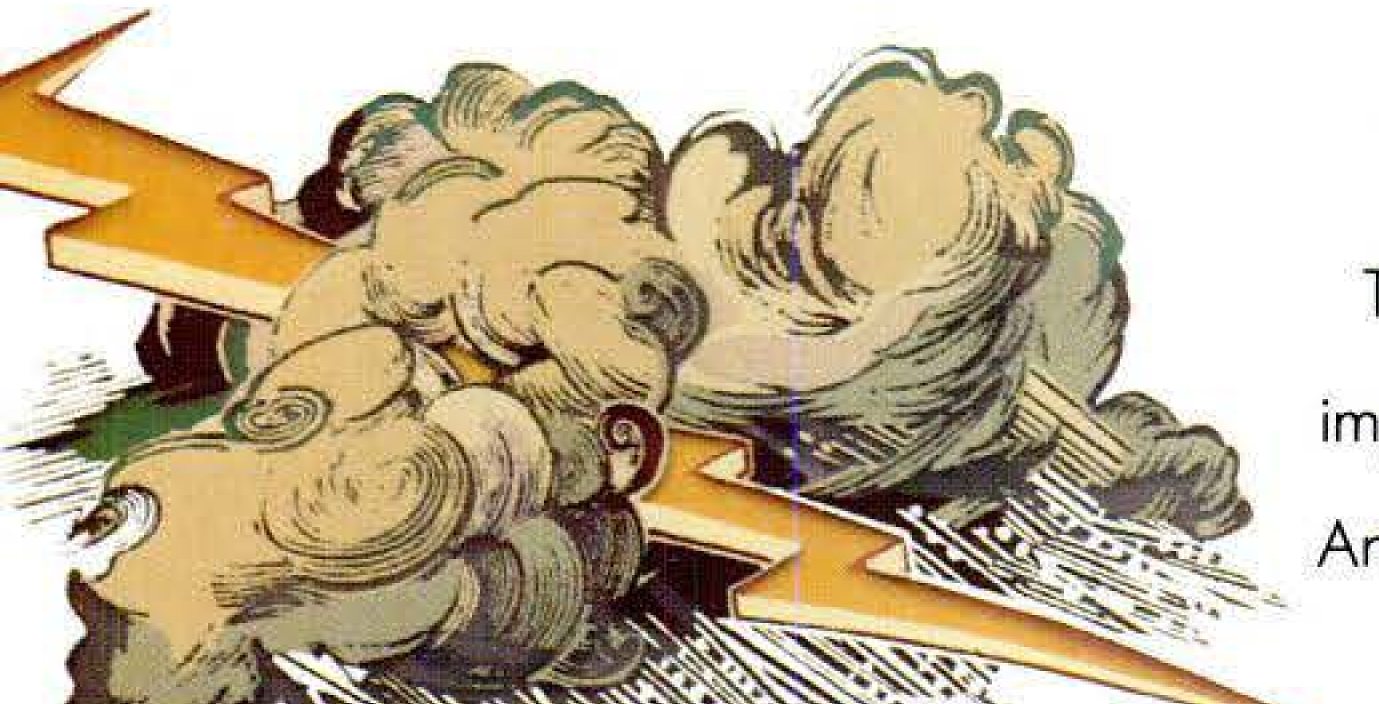
MICHELIN INTRODUCES THE TIRE THAT LETS YOUR PICKUP, VAN AND 4X4 RIDE LIKE A CAR AND WORK LIKE A TRUCK.



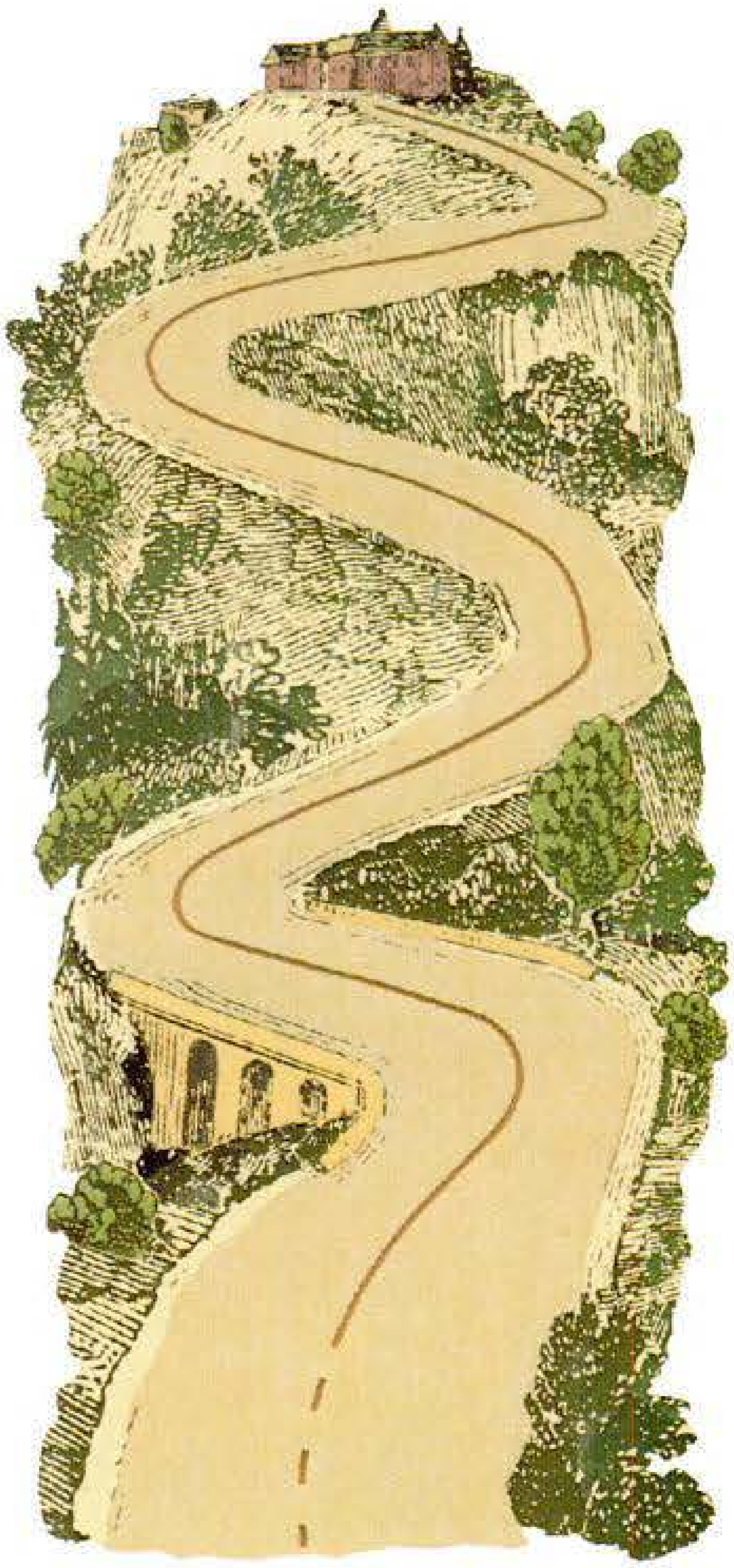
Big loads aren't a big deal
for the XCH4 radial. It gives you
the carrying capacity of
a light truck tire.
With the comfort of a Michelin
passenger tire.

The XCH4 is proof that a
light truck tire can work hard for you
without being hard on you.

The XCH4 is designed to wear
slowly, and just as
important, evenly. Which prevents
premature wearout.
And gives you the kind of mileage
Michelin is famous for.



Bad weather is good weather
for a Michelin.
The XCH4 all-season radial's
special tread design
and compounds provide excellent
traction and performance
in rain and snow.



The crisp handling and
precise response you expect from
a Michelin. Now your
vehicle can achieve all the
driving excitement and fun
it was designed for.

RADIAL XCH4
ALL SEASON

MICHELIN®
BECAUSE SO MUCH IS RIDING ON YOUR TIRES.℠

11 mg. "tar", 0.8 mg. nicotine
av. per cigarette by FTC method.

© 1985 R.J. REYNOLDS TOBACCO CO.

Winston.
America's Best.
Excellence.
The best live up to it.
KING SIZE
Winston
LIGHTS
SMOOTH RICH TASTE

SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.